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Fire Effects on Vegetation Structure, Composition, and Species Richness in Oak Woodland Habitats at Beaver Dam State Park and Chip-O-Will Woods

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INTRODUCTION

Prior to and in some cases immediately following European settlement of the eastern United States and the Midwest, including the region of Illinois, fire was a key landscape and community-level disturbance factor that shaped the distribution of forest, savanna, and prairie and influenced the composition and structure of the vegetation across this vegetational spectrum (Anderson 1983; Lorimer 1985; Ladd 1991; Abrams 1992; Anderson et al. 1999; Batek et al. 1999; Shumway et al. 2001). The decline in fire frequency with the fragmentation of the landscape and change in land-use practices has had major effects on vegetation in this prairie-forest transition zone. Many remaining areas of prairie and savanna (those not destroyed by land-use changes) developed into woodland. As a consequence of the extensive and antecedent fire history, many plant species occurring in the region are adapted to open situations and can be limited by shading. However, following long periods of fire absence, many oak-dominated woodlands throughout Illinois and the Midwest are now characterized by dense subcanopies of shrubs and saplings of non-oak species and little if any regeneration of the overstory oaks (Pallardy et al. 1988; Ebinger and McClain 1991; Loftis and McGee 1993; Taft et al. 1995; Taft 1997; Larson and Johnson 1998; Iverson et al. 2004). Many have sparse and depauperate ground-cover floras and infestations of non-native species.

Prescribed fire has had a growing role in the restoration of savanna and woodland habitats to reverse trends of declining oak regeneration and attrition of shade-intolerant ground cover species and fire-effects studies in Illinois oak woodlands have shown promising results (e.g., Taft 2003, 2005a). Additional studies are needed throughout the state in a variety of habitat types and ecological conditions to draw more general conclusions about restoration potential. With support from an Illinois Department of Natural Resources Wildlife Preservation Grant, a research and monitoring program was established from 2003 to 2005 at two sites: Beaver Dam State Park (Macoupin County) and Chip-O-Will Woods (Washington County). The major goals were to establish a program for ecological monitoring at these sites, collect before (baseline) and after data from fire treatment and fire-free reference areas, and examine effects of fire and fire absence on the structure, composition, and diversity patterns in oak woodlands at these locations.

Beaver Dam State Park (BDSP) already had been subdivided into a number of management units with varying recent fire histories. This provided an opportunity for comparative study with baseline vegetation data since individual woodland management units were present that had been burned three, two, and one time each while three units with no recent fire history could serve as fire-free reference sites for comparison. Only a small portion of Chip-O-Will Woods (C-O-W) had been treated with recent fire; the majority has not had a recent burn and long-term land owners are not aware of any past fires.

Principal assumptions in the study at Beaver Dam State Park were:

From Baseline Data

1. Tree density would differ among units with burned sites having lower tree density compared to unburned sites;
2. Shrub-sapling density would be lower among burned units compared to unburned units;
3. Ground-cover species richness and diversity would be greatest among burned units, particularly the burn units with the greatest recent fire history.

Fire Treatment Effects

1. Fire treatments would reduce tree density; however, effect would be limited to small diameter stems; tree density would increase in fire-free reference units; basal area would increase in both fire treatment and reference units;
2. Fire treatments would reduce stem density of saplings and shrubs while stem density would increase in fire-free reference units;
3. Ground-cover species richness and percent cover would increase in fire treatment units; ground cover species richness would decline in fire-free reference units.

Principal assumptions in the study at C-O-W were:

1. Fire treatments would reduce tree density; however, effect would be limited to small diameter stems; tree density would increase in fire-free reference units; basal area would increase in both fire treatment

and reference units;

2. Fire treatments would reduce species diversity and stem density of saplings and shrubs while stem density would increase in fire-free reference units;

3. Ground-cover species richness and percent cover would increase in burn units and decline in fire-free reference units. New emerging species would be characteristic for the habitat.

The null expectations in these comparisons is no difference among management units with differing fire histories and no changes attributable to fire treatment (Ho: units burned 3, 2, 1, and 0 times in baseline are equal; baseline = post-fire).

METHODS

Study Sites - Beaver Dam State Park is a 751-acre property of the Illinois Department of Natural Resources. It is located in Macoupin County about seven miles southwest of Carlinville (Figure 1) and occurs within the Carlinville Section of the Forest-Prairie Border Natural Division (Schwegman et al., 1973). The park receives substantial public use, particularly during summer months, for camping, hiking, fishing, and picnics. The park also is used by hunters. Forested portions of BDSP include several units that are mature oak-hickory woodland on rolling, moderately dissected topography; local areas of savanna species occur throughout the park and a remnant prairie opening is at the western boundary (McClain et al. 2002). Some forested areas are young and highly disturbed; other cover types include marsh, cropland, an impoundment, and managed public-use areas. Over 500 species of vascular plants have been reported from the park (unpublished list by Henry Eilers), including *Erythronium mesochoreum* (prairie trout lily), an uncommon spring ephemeral that ranges from the Great Plaines east to Illinois. It was only relatively recently discovered in Illinois (Roberston et al. 1983) and for a time was listed by the Illinois Endangered Species Protection Board (IESPB) as a threatened species. Recent revisions removed it from this list because it was determined to be more common than previously believed. Just outside the park boundaries is a population of *Astragalus crassicarpus* var. *trichocalyx* (McClain and Ebinger 2004), large ground plum, a species that is listed as threatened by the IESPB (IESPB 2005). Dr. Mariam Smith (SIU-E) recently commenced a detailed study of this

population.

The fire-management program at BDSP was initiated during the 1990s to restore aspects of the prairie-forest ecotone represented in the park and regionally. The park was subdivided into 18 burn units ranging in size from 2.5 acres to 64 acres. Four of the 18 units already had received fire treatments (units 4, 5, 15, and 17) at the outset of this study. Total number of previous burns (n) among burn units at BDSP were: Unit 4 (3), Unit 5 (2), Unit 15 (1), and Unit 17 (1). Units were selected for the current study with the goal to include sites with varying recent fire history and potential for restoration. Sites selected were units 4, 5, 7, 12, 15, and 18; units 12 and 18 served as fire-free reference sites (Figure 1).

The study area at Chip-O-Will Woods is an approximately 101-acre (40.7 ha) unit including private and adjacent IDNR property (Sipple Slough Woods) and is protected as a Natural Heritage Landmark. It is located in northwestern Washington County near the Kaskaskia River (Figure 2). This study area includes old-growth southern flatwoods and is recognized by the Illinois Natural Areas Inventory as a high-quality remnant. C-O-W has been subdivided into four management units, including Unit B (Figure 2) that received a fire treatment on 9 March 2001. There is a population of *Trifolium reflexum* (buffalo clover) known from the site, discovered in 1989 during an ecological study of vegetation and soils at this and other flatwoods (Taft et al. 1995). *Trifolium reflexum* is listed by the IESPB as a threatened species (IESPB 2005). This research suggested that in flatwoods the degree of vegetational changes with fire absence appears to be attributable to variation in soil water-holding capacity, a factor controlled by soil textural characteristics and the depth of the claypan. Sites with greater available water-holding capacity generally demonstrate the greatest structural and compositional instability and are most prone to vegetational changes in the absence of fire (Taft et al. 1995). C-O-W had been found in this previous research to be unusually sustainable in the overstory, with levels of oak regeneration that suggested both compositional and structural stability. This appears to be due to the unique edaphic conditions at the site. C-O-W occurs just east of the Kaskaskia River in a region that during post-glacial times was inundated by a slack-water lake. Fine sand deposited by this lake were wind blown and became incorporated into soils of C-O-W, contributing substantial amounts of sand to the upper horizons (50% to 55%).

The contrast from sandy A and E soil horizons to the claypan results in seasonal ponding and seasonal drying. Tree density in flatwoods is inversely related to available water-holding capacity of the soils (Taft et al. 1995); however, sandy soils have very limited capacity to retain moisture available to plants and quickly become arid with evapotranspiration during the summer months. Consequently, while level sites with a claypan can be seasonally moist, sites like C-O-W with sandy surface soils can become very dry during summer months due to evapotranspiration. The severity of this environment may lead to longer-term stability, or limited vegetational change. Although the overstory composition and structure of C-O-W appeared stable, the ground cover was very sparse (Taft et al. 1995). Was this low diversity a consequence of fire absence, the severity of the habitat, or a result of an island effect, since species would have had to immigrate to the site following drainage of the early post-Pleistocene lake? Soil seed banks can be important refugia for species during long fire-free intervals. A major goal of this study was to determine whether the soil seed bank was a source of diversity that could be stimulated by fire.

Vegetation Sampling

Both study sites were sampled with identical vegetation sampling protocols involving a stratified-random system of nested plots. Locations for vegetation sampling plots at each site were randomly determined using a Geographic Information System (GIS) randomization procedure and plots were stratified among selected management units for a total of nine at each site (Figures 1 and 2). Each point represents a centroid, marked by an angled iron fence post, for a triad of 0.05-ha circular plots located 50 meters from the center point and separated by 120° (plot 1 at 0° N, plot 2 at 120°, and plot 3 at 240°) yielding a total of 27 macroplots at each study site. Plot edges are separated by 61.36 m and with this degree of separation, each tree plot was considered independent. The center of the 0.05-ha plots were "permanently" marked with metal tree anchors twisted into the ground with just the metal loop above soil surface (despite remote locations, three of these went missing at BDSP in less than two years). Using coordinates of the centroids (Table 1), plots (when still in place) easily were relocated using, in this case, a Garmin Etrex global positioning system unit to find the center posts and a compass to find the tree plot centers.

Trees, saplings, and occasionally large woody vines (woody stems ≥ 5 cm dbh [diameter breast height]) were sampled in the 27 0.05-ha circular plots (radius = 12.62 m) at each location. Basal area (derived from dbh measurements) and density were recorded for all individuals of each species from each plot. Importance values for each species at BDSP were derived by summing relative dominance (basal area) and relative density (IV 200). At C-O-W, relative frequency was added as a component for estimating importance (IV 300) in this contiguous woodland. Density of shrubs and saplings (woody plants < 5 cm dbh and ≥ 50 cm high) was determined in a pair of 0.005-ha circular plots (3.99-m radius, n = 54), one nested at the center of each tree plot and the other at the outer edge of the tree plot along a randomly determined radius of the tree plot. The results from each pair of shrub-sapling plots were summed for a sample area of 0.01 ha within each tree plot (n = 27 at each site). Importance values for shrubs and saplings were calculated by summing relative density and relative frequency (IV 200).

Frequency and percent cover of ground-layer species (herbaceous species, tree seedlings and woody vines [< 50 cm tall]) were collected from 12 quadrats (0.5 m x 0.5 m) in each tree plot (n = 324 at each site). Ground-cover quadrats were located along a line transect at one-meter intervals extending in a randomized direction to the edge of the tree plot; the terminus of the transect was marked by a large nail in the ground. Plastic-covered wire line with loops at both ends and marks at one meter intervals served to re-locate the transect and quadrat and shrub-plot locations with dependable accuracy. Only plants rooted in the quadrats were recorded. Cover for each species was estimated with a cover-class scale (1=0-1%, 2=1-5%, 3=5-25%, 4=25-50%, 5=50-75%, 6=75-95%, 7=95-100% cover). Midpoints from cover classes were used in data analysis for each occurrence. Importance values for each species were calculated by summing relative cover and relative frequency (IV 200). Botanical nomenclature follows Mohlenbrock (1986).

Parthenium integrifolium (wild quinine) is one of the characteristic herbaceous species of prairies and savannas that also occurs in flatwoods. It is widespread at Chip-O-Will Woods (C-O-W). To track changes in treatment and control units in greater detail than possible in the 324 baseline quadrats, one tree plot (500 m^2) from each sampling triad was selected randomly for a complete census; in some cases where no plants were present, additional tree plots were censussed. Total

number of flowering and sterile ramets were counted during baseline and post-treatment samples.

At BDSP, plot locations were established during April of 2003. Vegetation sample dates for baseline data were collected for all plots from July 1 to July 9 2003. Vegetation sampling of post-fire data from Units 5 and 7 were recorded from 29 June to 9 July 2004. In addition, data were collected during 2004 from the control units 12 and 18 and Burn Unit 4. While data were collected from Unit 4 during 2003 and are used in this study for comparisons among baseline fire-frequency classes, the 2004 data served as the baseline reference for effects of the fire treatment examined in this study. This was because Unit 4 had been burned in 2002. Consequently, 2004 provided a more valid baseline for Unit 4 to contrast with data following the fire treatment (applied in spring of 2005 [see burn dates below]). Post-treatment data were collected for fire-treatment units 4 and 15 and all control plots between 20 June and 24 June 2005. At C-O-W, plots were established during April of 2003. Baseline data were collected between 15 and 22 July 2003 and post-treatment data were collected between 13 and 20 July 2004.

Experimental Design and Application

BDSP - Four units were treated with prescribed burns (units 4, 5, 7, and 15) and two remained fire-free and served as controls (units 12 and 18). Unit 5 was burned on 3 December 2003, Unit 7 was burned on 12 March 2004, and units 4 and 15 were burned on 16 March 2005. Unit 7 had not been treated previously with prescribed fire so the baseline data were included as previously unburned plots in a comparison of burned and unburned units. Burn dates, weather conditions, and fire behavior for fire treatments at BDSP and C-O-W are summarized in Table 2.

C-O-W - Units B and C were designated fire-treatment areas and units D1 and D2 were fire-free control areas. Units B and C were each burned independently on 26 March 2004. Temperature was about 70° F and winds were between 10 and 20 mph. Surface leaves were dry, but lower leaves were damp and matted. Some plots in the burn units were incompletely burned and one burn plot in Unit C was unburned and transferred for purposes of data analysis for this study to the fire-free reference category. See Table 2 for conditions at the time of the burns.

Data Analysis

Comparisons of vegetation parameters for the study at Beaver Dam State Park includes a contrast of the four fire-frequency categories that existed at the time of the baseline samples (no burn: units 7, 12, and 18; 1 burn: unit 15, 2 burns: unit 5, and 3 burns: unit 4). Patterns of abundance and species richness are compared among these management units for all vegetative strata. For both studies (BDSP and C-O-W) there are Before-After contrasts comparing data from baseline condition to post-fire responses in both fire-treatment and fire-free reference units. Vegetation parameters examined in the Before-After contrasts include, from the tree stratum: tree density, basal area, and species richness; from the shrub-sapling stratum: stem density and species richness; from ground-layer vegetation: species richness (at the scale of the transect), species density (average species richness per quadrat), and percent cover. Species density tends to be highly correlated to species richness at larger scales, such as at the transect-level, but can respond somewhat independently to fire.

A means comparison test (Analysis of Variance) was used to contrast vegetation parameters among the four baseline fire-frequency categories at BDSP. Within-treatment comparisons between time intervals at both sites were made using Paired T-tests to contrast baseline to post-burn changes among vegetation parameters. Ordination using Detrended Correspondence Analysis (DCA) was used to graphically depict baseline patterns of species composition and study units.

Replicate plots were randomly located within burn units at both sites to provide a greater representation of within-site vegetation and fire-effects variability. These were considered independent replicates for statistical analysis in both the fire-free reference and fire-treatment units. While the opportunity to establish four fire treatments at BDSP and two at C-O-W provided an excellent opportunity to study within-site variability and trends, a sample size of up to four provides only limited statistical power to make broader inference. Consequently, inference in this study primarily is limited to each site; broader inference needs to be made with some caution (i.e., Hurlbert 1984). A main concern with replication of treatment units only within-site(s) is the possible effects on error rates, or variance about the mean compared with likely more variable between-site comparisons. This can lead to Type I statistical errors, or a greater likelihood of detecting differences where none might exist in between-site

comparisons. The statistical tests used to detect effects of fire treatments applied for this study are intended to highlight differences in means that were greater than expected in a null expectation of no change.

RESULTS

Beaver Dam State Park

Baseline Data (2003)

Tree Stratum - Total tree density among sample units was 796 trees/ha with basal area of 25.83 m^2/ha. A total of 28 tree species (including two vines > 5 cm dbh) were recorded from the 27 baseline plots in the six study units (Table 3). Six species have importance values (IV 200) greater than 10 accounting for about 69% of the total importance value among trees. These species, in descending rank order of abundance, are *Ulmus rubra, Celtis occidentalis, Quercus alba, Q. velutina, Carya ovata,* and *Q. stellata* (Table 3). *Ulmus rubra* is by far the most common species with 243 trees (≥ 5 cm dbh) per hectare, almost double the density of *Celtis occidentalis*, the next most abundant species. Oaks (*Quercus* species) comprise about 38% of the total importance value (IV 200) among species while hickories (*Carya* species) comprise about 10% of the IV. Together, oaks and hickories account for about 49% of the IV among trees at the sampled management units; however, there is some variation among units (Table 3). Tree species data from each unit are summarized in Appendix 1.

The distribution of size classes indicates that oaks are the primary species among the larger size classes, while most other species are confined to the smaller diameter classes (Figure 3). The over-all distribution of size classes indicates that oaks also are represented among the smaller size classes; however, individual patterns among management units reveal that this is due largely to positive recruitment patterns at units 4, 5, and 7; units 12, 15, and 18 show little oak regeneration despite oak dominance in the intermediate and largest size classes (Figure 4a-c). There is a curious dip in size-class distribution for oaks and hickories at Unit 4 in the 10 cm to 30 cm dbh range; in place of oaks and hickories in this range are peak abundances for *Celtis occidentalis* and *Cercis canadensis.*

An ordination scatterplot, based on baseline tree importance values, indicated that fire-treatment plots and reference plots intermix (Figure 5) supporting use of the reference plots for comparison with

treatment plots. Much of the variance in the data is explained by the strong association plots from both treatment and control units have with the dominant species: *Quercus alba, Quercus velutina, Q. stellata, Ulmus rubra, Celtis occidentalis,* and *Carya ovata.* Most of the outlying species in the ordination were scarce and located in Unit 7 (Figure 5).

A comparison of tree density, basal area, and species richness among the four fire-frequency classes indicated there were no statistically significant differences (Figure 6). Perhaps unexpectedly, the unit burned most frequently (Unit 4 with three burns) had the highest basal area among fire-frequency classes (Figure 6). Among units, Unit 4 and Unit 12 had the greatest basal areas among stands and were nearly identical (28.01 m^2/ha and 28.19 m^2, ha, respectively); Unit 4, with 660 trees/ha - the lowest among all six units, had the highest average diameter per tree. A comparison of previously burned and unburned plots (plots from units 4, 5, and 15 [burned units] vs. 7, 12 and 18 [unburned units]) also indicated no differences between the groups for tree density, basal area, and species richness (Figure 6). The averages were nearly identical for tree density and basal area (39.3 trees/plot vs. 40.3 trees/plot and 1.315 m^2/plot vs. 1.298 m2/plot, respectively) while plots that had been burned averaged one less species than unburned plots (8.4 vs. 9.5).

Shrub-Sapling Stratum - Total density of stems in the shrub-sapling stratum among sample units averaged 13,844 stems/ha. Forty-four shrub-sapling species were recorded from the 27 baseline plots in the six study units (Table 4). As with the trees, six species have importance values (IV 200) greater than 10 accounting for about 55% of the total importance value. These species, in descending rank order of abundance, are *Ulmus rubra, Rosa multiflora, Celtis occidentalis, Lonicera maackii, Ribes missouriense,* and *Rubus pensylvanicus* (Table 4). Like the trees, *Ulmus rubra* is by far the most common species with 2,852 stems (< 5 cm dbh, > 50 cm tall) per hectare. Oaks (*Quercus* species) comprise about 4.5% of the total importance value (IV 200) among species while hickories (*Carya* species) comprise about 6% of the IV. However, there is variation among units with recently burned units having somewhat lower abundance of oak-hickory species compared to unburned units (Table 5). Two of the dominant species, *Rosa multiflora* and *Lonicera maackii*, are non-native; however, sites differ in the proportion of non-native species. Non-native species comprised only about

1.5% of the importance value at Unit 4 while non-native species comprised about 35% of the importance value at Unit 7, the greatest among units sampled at BDSP (Table 5). Unit 4 has been burned three times in recent years prior to this study and Unit 7 had no previous burns. Other patterns of non-native species abundance appear unrelated to fire history. Unit 5, burned twice, has a similar proportion of non-native shrub species compared with unburned Unit 12 (Table 5). Shrub-sapling species data from each unit are summarized in Appendix 2.

Based on shrub-sapling density for each plot, an ordination scatterplot using DCA indicates that fire-treatment plots and reference plots intermix (Figure 7) but that reference plots form a central cluster within more variable treatment plots. Plots differ according to association patterns with particular species. Unit 4 plots form a distinct cluster and associate with *Rhus aromatica, R. glabra, Campsis radicans, Sassafras albidum, Ptelia trifoliata,* and *Zanthoxylem americanum.* Unit 7 plots associate with *Crataegus* species, *Rosa multiflora, Lonicera maackii, Eleagnus umbellata, Quercus rubra,* and *Q. muhlenbergii.* Most other plots form a central cluster associating with several other species, particularly the ubiquitous *Ulmus rubra, Celtis occidentalis, Cercis canadensis,* and *Fraxinus americana* (Figure 7). Based on the distribution of species and plots in the ordination, the first axis is interpreted as primarily a moisture gradient with more moist plots represented by increasingly positive scores (towards the right); the second axis is interpreted as a disturbance, or degradation, gradient associated with past grazing. Plots scoring most positively on the second axis are associated with species of mesic woodland (e.g., *Quercus rubra*) and include many that are typical of degraded woodland, often with a history of grazing by domestic stock (e.g., *Ribes missouriense, Crataegus species, Lonicera maackii, Rosa multiflora*).

A multiple comparison of shrub-sapling density among the four fire-frequency classes indicated the unburned units had a greater density of stems compared to plots with a fire history but the difference was not statistically significant (Figure 8). However, a two-way comparison of burned and unburned plots (plots from units 4, 5, and 15 [burned units] vs. 7, 12 and 18 [unburned units]) indicated burned plots had lower density of shrubs and saplings and the difference was significant (Figure 8). Species richness was lowest at the most frequently burned unit, but the difference was not significant; there also was no difference in species richness among burned vs. unburned plots (Figure 8). The proportion of

shrubs and saplings differs among burn units, but not consistent with burn number (Figure 9).

Ground-Cover Stratum - A total of 143 species were recorded in the 324 quadrats (12 quadrats/plot, 27 plots) established in this study (Table 6). The top five dominant species in descending rank order of abundance (IV 200) were *Parthenocissus quinquefolia, Sanicula odorata, Ulmus rubra, Eupatorium rugosum,* and *Circaea lutetiana* comprising about 46% of the total IV among species. Mean species richness was about 26 per transect, mean species density was 6.5/0.25-m^2 quadrat, and mean percent cover was about 65%. Most species were scarce: 110 species (77%) occurred in less than 25% of the transects and 39 species (27%) were recorded from a single transect; 23 species (16%) occurred in a single quadrat. Only three non-native species were recorded in the ground-cover stratum, all woody species also found in the shrub-sapling startum *(Lonicera maackii, Rosa multiflora,* and *Morus alba*) and these comprise only about 1.7% of the total importance value among species. Ground-cover species data from each unit are summarized in Appendix 3.

The ground cover was comprised mostly of perennial forbs with 51 species totaling 43.5% of percent cover (Figure 10). Woody species (tree seedlings, woody vines, shrubs) made up about 38% of the total cover with woody vines most prominent (23% of total cover). The remaining 18.5% of cover was made up of perennial grasses, perennial sedges, annuals, biennials, herbaceous vines, and ferns. After perennial forbs, tree seedlings, with 15 species, were the most diverse physiognomic group followed by perennial grasses (14 species), and native shrubs and annuals (each with 13 species).

A Detrended Correspondense Analysis (DCA) scatterplot based on percent cover of the 50 most abundant species (Figure 11) indicates that plots from units burned more than once are found on the left side of the first axis associated with perennial herbaceous species (e.g., *Carex albicans, Muhlenbergia sobolifera, Solidago ulmifolia, Silene stellata, Helianthus strumosus, Elymus hystrix, Bromus pubescens,* and *Phryma leptostachya*) and once-burned and unburned plots occur on the more positive side of the first axis associated with woody vines, tree seedlings, and shrubs (e.g., *Parthenocissus quinquefolia, Ribes missouriense, Celtis occidentalis, Symphoricarpos orbiculatus, Ulmus rubra,* and *Smilax hispida*). Past burned plots form relatively discrete clusters with plots from Unit 4 and Unit 5 associating with several distinct species. Unit 4 plots are closely

associated with the herbaceous species listed above while Unit 5 plots are most closely associated with *Sanicula odorata, Campanula americana, Pilea pumila, Rubus pensylvanicus,* and *Cinna arundinacea.*

Multiple comparisons of major ground-cover parameters (species density, species richness, and percent cover) among the four fire-frequency classes indicated a consistent pattern with higher values for units with greater number of recent burns and for all comparisons and overall differences were statistically significant (Figure 12). Tukey post-hoc tests indicated that the differences mostly are between Unit 4, burned three times prior to this study, and once-burned or fire-free units (Units 7, 12, 15, and 18). Unit 5, burned twice prior to this study, was intermediate (and statistically indistinguishable) in species richness, species density, and % cover between unburned or once-burned units and Unit 4 (Figure 12). Paired comparisons of burned and unburned plots (plots from units 4, 5, and 15 [burned units] vs. 7, 12 and 18 [unburned units]) indicated burned plots had greater species richness, species density, and percent cover and the differences were significant for all but species richness, which at $P = 0.06$, is just below ? (0.05) set for this study (Figure 12).

There is an inverse correlation between tree density and ground-cover species density in the baseline burn plots ($R^2 = 0.38$, df = 13, $P < 0.05$); however, when all data are examined including reference plots, the relationship is not present.

Post-Fire Responses

Canopy Stratum - Among combined treatment and reference sample plots, tree density, basal area, and species richness changed only slightly from the baseline to the post-burn samples. Tree density declined from 796/ha to 787/ha, basal area increased from 25.63 m^2/ha to 26.05 m^2/ha, and species richness declined from 28 to 26 species. Two extirpated species, *Ulmus americana* and *Morus alba* (non-native), occurred in baseline fire-treatment plots as only one or two individuals, respectively. In the combined treatment and reference plots, there was little change in the rank abundance among species.

In fire-treatment plots, tree density declined from 829/ha to 781/ha. Basal area declined slightly from 25.71 m^2/ha to 24.99 m^2/ha, and species richness declined from 26 to 22 species as scarce

species declined to zero (in addition to *Morus alba* and *Ulmus americana*, two species also occurring in reference plots, *Fraxinus americana* and *Vitis riparia*, were extirpated from treatment plots). Totals for all *Quercus* species combined indicated a slight decline in density of 4.3 trees/ha; however, basal area among *Quercus* spp. increased slightly indicating the decline was limited to small diameter trees.

Before:After mean-plot differences in tree density indicate that the decline in fire-treatment plots was statistically significant ($t = 2.99$, df. = 13, $P < 0.01$; Figure 13). There was variation among sites in the degree of decline. Unit 4, with the most intense fire in this study (Table 2) and greatest fire history among sites, had the largest overall decline (12%) while the reference sites increased in density 7%-to-11% (Table 7). Mean plot differences in tree basal area and species richness were not significant.

Most species in fire treatment plots declined in density (trees per unit area) while a few increased (Figure 15). Among oaks, slight declines were recorded for *Q. alba, Q. imbricaria, Q. rubra,* and *Q. stellata* and slight increases were recorded for *Q. macrocarpa* and *Q. muhlenbergii*; *Q. velutina* remained unchanged (Figure 15). *Celtis occidentalis* and *Cercis canadensis* were the species with the greatest overall decline in density with a reduction of about 13 and 10 trees/ha, respectively.

Differences in the distribution of size-classes for all tree species indicated that the reduction in density in fire treatment units was limited to small diameter classes; changes in larger size classes are related to transitions from one class to another. Changes in reference plots indicate an increase in the smallest size class (5 cm to 10 cm dbh) to a similar degree as the decline in fire treatment plots (Figure 14).

Shrub-Sapling Stratum - Total shrub-sapling density in combined treatment and reference plots changed from 13,844 stems/ha to 11,100/ha; the majority of decline was from fire treatment plots. Average density in 0.005-ha fire-treatment plots declined from 65.7 to 42.3 and the difference was significant (paired t-test: $t = 3.18$, df = 27, $P < 0.004$); there also was a decline, though more slight, in reference plots (Figure 16). In burn plots there was a disproportionate decline among sapling species (-54%) compared to shrub species (-23%). In reference plots, shrub density increased about 12%

(Figure 17); however, there was a decline among saplings (-22%), mostly due to a reduction (33%) in *Ulmus rubra*. Fire treatment sites differed in their response to fire. Unit 15 had the greatest decline in shrub-sapling density (62%) while units 4 and 7 had 25% and 24% decline, respectively (Table 7). Unit 5 had very little decline in tree or shrub-sapling density; the fire treatment in Unit 5 had incomplete coverage (Table 2).

Species richness declined in fire treatment plots from an average of 7.5 to 5.4 species (Figure 16) and the change was significant (paired t-test: $t = 5.87$, $df = 27$, $P < 0.00001$). There also was a decline in reference plots, from 8.1 to 7.6 species and the difference was nearly significant ($P = 0.062$), based on a null expectation of no change in a before-after paired comparison.

Changes among shrub-sapling species indicate that 13 declined in both treatment and reference plots and three increased. The remaining species demonstrate mixed responses with some showing apparent fire effects (i.e., declining in treatment plots, increasing or no change in reference plots: *Symphoricarpos orbiculatus, Staphylea trifolia, Rosa multiflora, Corylus americana,* and *Carya cordiformis*). Others show decline in both sets of plots but the decline in fire-treatment plots was much greater (e.g., *Celtis occidentalis* and *Ulmus rubra*). *Lonicera maackii* increased in both reference and treatment plots but the increase in fire-treatment plots was half the increase in reference plots (Figure 18).

In fire-treatment plots, several shrub species show noteworthy decline based on total proportion of change (Figure 19) with six declining over 50% of baseline levels (*Corylus americana, Euonymus atropurpureus, Rhus glabra, Ribes missouriense, Sambucus canadensis,* and *Symphoricarpos orbiculatus* [underlined species declined 100%; *S. orbiculatus* declined 90%]). Summarizing results for non-native species, there were mixed results with a decline of 40% for *Rosa multiflora* and an increase of 23% for *Lonicera maackii* (Figure 19). *Rubus pensylvanicus* was the only other shrub species to increase (23%) in the fire treatment plots.

Two sapling species, *Carya ovata* and *Morus rubra*, increased in the fire-treatment plots and the increase was 50% or greater; however, both species were relatively scarce in the baseline sample and the total change in density was minor (Figure 20). *Quercus bicolor* was recorded (two individuals) following fire treatment, but was absent in the baseline sample. Twelve sapling species declined 50% or

greater in the fire-treatment plots; five of these declined 100% (*Crataegus mollis, Juglans nigra, Malus ioensis, Prunus* sp., and *Q. imbricaria*); however, all were scarce in the baseline sample (Figure 20; Table 4). *Ulmus rubra* had a particularly noteworthy decline of 244 stems throughout the fire treatment sample units (75% of total).

Increase and decline was more balanced among shrub species in the fire-free reference plots with five declining and eight increasing species (Figure 21). Three species declined 100% but all were present only as a single stem in the baseline samples. *Ribes missouriense* was the dominant shrub species in the reference plots; however, there was a 26.5% decline even without fire treatment. Two species had large increases (> 50%) including the non-native *L. maackii* (70%) and *Rubus pensylvanica* (51.5%). Among saplings in the reference plots, most species declined except three that were scarce in the baseline sample (Figure 22). *Ulmus rubra* had the most prominent decline in total number of stems, losing 33% (146) during the study.

Ground-Cover Stratum - Total species richness following fire treatments was 139 for all plots sampled at Beaver Dam State Park. A total of 126 were recorded from the 14 fire-treatment plots (168 quadrats) and 80 were recorded from the 13 fire-free reference plots (156 quadrats). Mean species richness, species density, and percent cover increased in fire treatment plots and decreased in fire-free reference plots (Figure 23) and for species richness and species density the differences in fire-treatment plots were statistically significant (paired t-test: $t = -3.07$, $df = 13$, $P = 0.009$ and $t = -5.7$, $df = 13$, $P < 0.0001$, respectively). The decline in mean species richness at the reference plots also was statistically significant (paired t-test: $t = 2.2$, df. = 12, $P = 0.045$). Units differed in response to fire. The greatest increase in species density was in Unit 15 (26%) and Unit 7 (19%). Species density in Unit 18, a fire-free reference unit, declined 38% during the short span of this study (Table 7).

A greater proportion of species that increased in frequency and percent cover (Increasers) and New Species were in fire-treatment plots; in contrast, a greater proportion of species that decreased in frequency and percent cover (Decreasers) and Extirpated Species were in the fire-free reference plots (Figure 24). Eighty-four species (60%) increased in frequency in fire-treatment plots combining species from Increaser, New Species, and Mixed Response I species (increased or same in frequency,

decline in cover) while 76 increased in percent cover (Table 8). Species with major increases in frequency (> 10 quadrats) include: *Acalypha virginica, Eupatorium rugosum, Hackelia virginica, Phryma leptostachya, Prunus serotina* and, among new emerging species, *Acalypha rhomboidea, Chenopodium standleyanum,* and *Conyza canadensis.* Only one sedge, *Carex oligocarpa,* was recorded as an Increaser. Seventy-six species (55%) increased in cover including Increaser, New Species, and Mixed Response II (increased in cover, decline or same in frequency) species (Table 8). Species with the greatest increases in percent cover include: *Circaea lutetiana, Eupatorium rugosum,* and *Sanicula odorata.* Species with greatest decline in fire-treatment plots were *Parthenocissus quinquefolia* and *Impatiens capensis.* Species with greatest decline in percent cover were *Helianthus strumosus, Impatiens capensis,* and *Parthenocissus quinquefolia.* Most extirpated species (11 of 15) were present in only a single quadrat during baseline sample (Table 8).

In fire-free reference plots, species with the greatest increase in frequency were *Carex blanda* and *Circaea lutetiana* (Table 9). Species with the greatest increase in percent cover were *Galium circaezans, Parthenocissus quinquefolia, Prunus serotina,* and *Carex radiata.* Species with greatest decline in frequency were *Eupatorium rugosum, Pilea pumila,* and *Polygonum virginicum* while species with the greatest decline in percent cover were *Eupatorium rugosum, Sanicula odorata,* and *Ulmus rubra.* Ten of 19 Extirpated Species were present in baseline sample from a single quadrat.

There remains an inverse correlation between overstory tree density and ground-cover species density, although following the fire treatment, the strength of the correlation declined slightly from the pre-burn condition ($R^2 = 0.32$, df = 13, $P < 0.05$).

DISCUSSION

The specific assumptions with this study at BDSP were realized. In the fire-treatment units, tree density declined and the decline was limited to small-diameter stems; shrub and sapling density and species richness declined, while ground cover richness, density and percent cover increased and many of the differences were greater than expected by random chance. In general, trends in the reference units were opposite with increases in tree and shrub density and decreases in ground-cover richness,

density, and percent cover; sapling density declined slightly.

Studies of fire effects in Illinois oak woodlands (Taft 2003, 2005a) have shown infrequent fire (3 or less in 15 years) to have only minor or negligible effects on tree basal area. However, in Minnesota oak savannas (Peterson and Reich 2001), fire frequency of 2 or more per 10 years resulted in declines in basal area of 4 to 7% per year and greater loss was found in longer-term histories of more frequent fire ($\geq$ 4 in 10 years). The differences may relate to different fuel loads in the ground-layer with the savannas having more graminoid fuel to carry hotter fires that are more damaging to cambial tissues. Since decline in tree density is primarily limited to small-diameter stems, which contribute little to stand basal area, tree density appears more sensitive to infrequent or occasional fires, such as in most units at BDSP, compared to basal area. Thicker bark on older trees provides greater protection to cambial tissues (Harmon 1984; Russell and Dawson 1994). Interestingly, Unit 4 in this study, with four recent burns, ranks with unburned Unit 12 with the greatest stand basal area among management units at BDSP (28.0 and 28.2 m^2/ha, respectively). In Minnesota savannas, *Quercus macrocarpa* showed resistance to further declines in basal area with increasing fire frequency once a threshold was reached (Peterson and Reich 2001). It may be that the tree stratum at Unit 4, primarily oaks (about 57% of IV), will resist additional fire damage and any further decline in basal area with additional fire management might be limited to declines in *Celtis occidentalis* and *Cercis canadensis*, two apparently fire-sensitive species.

Given the antecedent fire history in the Midwest, particularly in ecotonal areas such as in the region of the Prairie-Forest Border Division, and the shade intolerance of oaks and many ground-cover species, it remains a major conundrum how best to manage oak woodlands to achieve some level of sustainability in the overstory composition and prevent attrition of ground-cover diversity (Brose et al. 1999). Prescribed fire has been used widely to achieve these goals and many of the trends in this study appear to be consistent with the general patterns. It needs to be determined how to adjust fire frequencies to best achieve these goals. Stands need to be opened up to encourage both regeneration of oak seedlings and reverse trends of attrition in the herbaceous vegetation. However, fire tends to consume young seedlings and saplings of both oak and non-oak species. Once stands are thinned with fire, periodic fire-free intervals likely will be needed to recruit oak seedlings into larger size classes

where bark thickness affords fire tolerance. Topics of specific concern in oak woodland management including oak regeneration, exotic species control, and restoration of the ground-layer vegetation are discussed in more detail below.

Oak Regeneration - Fire appears to be a key element in the regeneration of oaks in oak woodlands (Abrams 1992; Lorimer 1985; Shumway et al. 2001). The duration of this study was too short to evaluate the effects of the fire treatments on oak regeneration. While fire in the short-term may have negative impacts on existing oak seedlings and saplings, oaks can resprout and quickly recover to pre-burn conditions (Larson and Johnson 1998). Further monitoring would be needed to examine oak regeneration patterns. Oak seedlings were extremely scarce in this study and while they showed some increase, the differences were minor. Oak seedlings were abundant in Minnesota savannas and demonstrated resistance to fire (Peterson and Reich 2001). More available light may be needed in most units at BDSP before oak seedlings can become established. Oak saplings were scarce in all units at BDSP with a maximum sum of 6% of the IV among shrubs and saplings. No oak saplings were recorded from Unit 15.

While oaks currently are dominant in the largest tree size classes in all sample units at BDSP, they are scarce in the smallest tree size classes and only show moderately positive recruitment patterns at units 4, 5, and 7. Unit 4, despite the four recent burns, has among the strongest recruitment pattern among units in the smallest size class (5 to 10 cm dbh). The dip in oak and hickory abundance at Unit 4 in the 10 to 30-cm dbh range may be related to past disturbances such as grazing. Past burns can probably be dismissed as a factor in this pattern. One of the dominant species in this size-class range, *Celtis occidentalis*, appears to be fire sensitive (this study; Taft 2005a) so presumably did not become established as a result of previous burns occurring prior to the recent fire-management program. However, Unit 7, a highly disturbed area with an apparently extensive past history of livestock grazing, has the strongest pattern of oak regeneration among units but unlike Unit 4 does not show a bi-modal size-class distribution among oaks. This pattern may date to more open conditions following release from grazing. Current conditions, with abundant *Ulmus rubra* and *Celtis occidentalis* in the small diameter classes and dense shrub layer of the exotics *Rosa multiflora* and *Lonicera maackii* may limit

further oak recruitment without intervention such as additional fire treatment. Under current conditions, with a pause in fire management there is a much greater likelihood of successful oak recruitment in Unit 4 with 580 trees/ha compared with Unit 7 with 857 trees/ha.

Exotic Species Control - The majority of exotic species at BDSP occur in the shrub-sapling stratum. Among shrubs and saplings, *Ulmus rubra, Celtis occidentalis*, and several shrubs (e.g., *Symphoricarpos orbiculatus, Staphylea trifolia, Corylus americana, Rosa multiflora*, and possibly *Ribes missouriense*) appear particularly sensitive to fire. The decline in *R. multiflora,* originally ranking as the most abundant shrub at BDSP sample units, suggests potential for general control with prescribed fire for this common and widespread invasive exotic species. While there were reductions in many species, many shrubs and saplings resprout and can recover relatively quickly to preburn levels (Taft 2003), or even exceed preburn levels (Taft 2005a).

Lonicera maackii, originally ranking second among shrubs in baseline stem abundance, increased in both treatment and reference samples, but the increase in treatment plots was half that from reference plots. However, with reductions of *Ulmus rubra*, *Celtis occidentalis*, and *Rosa multiflora*, this invasive exotic ascended to the top-ranking species in the shrub-sapling layer. About 81% of the increase for this species among treatment samples was from plots in Unit 7 that following evaluation of fire coverage were only very lightly burned. The plot with the greatest increase in *L. maackii*, also in Unit 7, had been re-assigned as a fire-free control due to incomplete fire coverage. The great abundance of both *R. multiflora* and *L. maackii* at Unit 7, comprising about 50% of stems in the shrub-sapling stratum, together with low fuel characteristics on the ground layer (bare ground in baseline ground-cover sample was estimated to be about 45%), resulted in a discontinuous and spotty burn in portions of the unit (it was estimated that only 60% of the unit was affected by the burn). Following the fire treatment, the estimate for bare ground was reduced to 30% suggesting that continued fire management may yield improved fuel conditions for more effective burns, particularly with the reduction in R. multiflora in the shrub layer. Mechanical thinning of both *R. multiflora* and *L. maackii* may be needed, especially in Unit 7, for greater fire coverage and more intense burns effective in further limiting, or possibly controlling, *L. maackii*.

Ground-Cover Restoration - The significant increases in ground-cover species richness and species density are consistent with other studies in Illinois woodlands (Taft 2003, 2005a). Unit 4, with 4 burns in the past 10 years, had 25% greater species density (species per quadrat) compared to the next richest unit (Unit 5) and almost triple the density of species found in the combined reference units. A similar difference was found between burned and unburned flatwoods (Taft et al. 1995).

The species with greatest increase in fire-treatment units at BDSP (e.g., *Acalypha virginica, Circaea lutetiana, Eupatorium rugosum, Phryma leptostachya,* and *Sanicula odorata*) primarily are species that were common in the baseline sample and also were the major increaser species in a burn study in a degraded old second-growth flatwoods (Taft 2005a). These species, while native, generally are associated with disturbed woodlands, particularly when abundant. However, among species that increased in frequency and new species were several taxa not associated exclusively with degraded woodlands (e.g., *Carex albicans, Carex hirtifolia, Carex oligocarpa, Dichanthelium clandestinum, Elymus hystrix, Festuca obtusa, Galium circaezans, Muhlenbergia sobolifera*, and *Smilax racemosa*).

Of interest is not only the increase in species richness in ground-layer vegetation with woodland burns, but the loss of diversity in fire-free reference units in this and other studies (e.g., Taft 2003). In the present study, the loss of species richness during the span of the study in fire-free reference plots was more than expected from random chance. Declining and extirpated species from reference plots included many herbaceous graminoid and perennial forb species typical for the habitat. This is consistent with an attrition hypothesis which predicts gradual decline in herbaceous ground cover during long fire-free intervals which can be correlated with increasing stem density in the woody strata and, correspondingly, increasing shade. That the fire treatment plots show an inverse correlation between overstory structure (tree density) and ground-cover species density can be interpreted as a signal of restoration potential. Where this pattern is absent, such as with reference plots, it suggests that either tree density has yet to limit abundance patterns of ground-cover species or, as in this case, only primarily shade-tolerant species remain and species intolerant of shade are scarce or are missing from the species pool. While some savanna/open woodland indicator species are present in the treatment and

reference sample units (e.g., *Bromus pubescens, Cacalia atriplicifolia, Carex* spp. [*C. albicans, C. hirsutella, C. cephalaphora*], *Elymus hystrix, Monarda bradburiana, Scutellaria incana, Veronicastrum virginicum*, and *Woodsia obstusa*), most occurrences are in fire-treatment plots. This suggests that attrition of ground-cover species already has resulted in a depauperate flora in these units and the low richness and density of species in reference units12 and 18 supports this assumption.

Data from dry barrens in southern Illinois (Taft and Solecki 2002) suggests there is a threshold in tree density relative to ground cover diversity whereby density greater than about 25 trees/0.05-ha (plot), or 500/ha, corresponds to progressively declining ground-cover diversity. All units at BDSP currently exceed these levels suggesting there already has been the possibility of loss of diversity. Unit 4, with the lowest tree density among study sites following four burns, has an estimated 580 trees/ha (33 trees/0.05 ha). A mean tree density of 25 to 30 trees/0.05-ha plot provides a possible benchmark for management goals. Some experimental trials combining tree thinning with prescribed fire likely would accelerate restoration of the ground-cover. With a continuation of the fire-management program at BDSP, as stands are opened up there would be an opportunity to introduce species appropriate for the habitat from local sources to compensate for past attrition of diversity, particularly from the herbaceous ground-layer.

CONCLUSIONS

Presettlement vegetation at Beaver Dam State Park, considering its geographic location, natural features including occurrences of glacial drift prairies, scattered savanna species, and overstory dominance of oaks, was probably a mosaic of open oak woodland with prairie openings and local areas of forest associated with the major drainages. Fire absence, logging, livestock grazing, and exotic species infestations are past general disturbance factors that occurred throughout the park that have had a lasting effect on the contemporary vegetation structure and composition. The fire management program so far appears to have had only minor impacts on stand basal area but is beginning to affect structure, particularly in the most frequently burned unit, by reducing the density of small-diameter trees, saplings, and shrubs. Ground cover species richness and percent cover are significantly greater in the burned units, particularly Unit 4. However, no pre-burn baseline data are available for this unit to

distinguish recent fire effects from overall changes since the initiation of the fire-management program, or to help determine whether vegetation similar to Unit 4, in terms of composition, structure, and diversity, could be achieved in other units with repeated treatments of prescribed fire.

Generally, there is a greater opportunity for restoration in a relatively continuous or at least linked woodland habitat such as BDSP than in isolated sites where there are limited sources and opportunities for species immigration to recharge the species pool. The fire treatments in this study varied in intensity. In two units, the burns were discontinuous and some plots were incompletely burned or were unburned due to weather conditions at the time of the fires and existing spotty fuel characteristics. The greatest fire intensity was in Unit 4, in part because fire conditions were improved on that burn date compared to the other burns in this study, but also because the openness of the stand permitted greater air movement. Unit 4 fuel characteristics, with substantially greater herbaceous ground cover (less bare ground), probably also contributed to a more effective burn. More effective burns could be expected in other units with a continuation of the fire management program as the tree density gradually would decline and ground cover would increase. Nevertheless, restoration of open woodland habitat throughout BDSP would require a long-term commitment in most units (at least 10 to 20 years). Restoration could be accelerated by focused species introductions in localized areas and possible mechanical thinning of woody strata, particularly thickets of exotic shrubs, and trees in the non-oak or hickory species groups (e.g., *Ulmus rubra, Celtis occidentalis*).

Chip-O-Will Woods

Baseline Data (2003)

Tree Stratum - Total tree density, based on 27 tree plots (0.05-ha) stratified among treatment and control units, was 536 trees/ha with basal area of 26.08 m^2/ha. Density ranged from 462/ha in Units D1 and D2 (combined) to 598/ha in Unit C; basal area ranged from 24.1 m^2/ha in Unit B to 28.3 m^2/ha in Unit C (Table 10). Twenty-two tree species were recorded from the baseline samples in the four study units (Table 11). Five species had importance values (IV 300) greater than 10 accounting for about 83% of the total IV among trees. These species, in descending rank order of abundance, were *Q. stellata* (with 52% of the total IV), *Carya ovata, Ulmus rubra, Q. marilandica,* and *Q. velutina.*

Quercus stellata was by far the most common species with 276 trees (≥ 5 cm dbh) per hectare, almost 4.5 times the density of the next most abundant species, *C. ovata*, and basal area 22.5 m^2/ha, 86% of the site total (Table 11). Oaks (*Quercus* species combined) comprise about 65% of the total importance value among species while oaks and hickories (*Carya* species) comprise about 77% of the IV. Data for each sample unit is summarized in Appendix 4.

The distribution of size classes among species shows *Q. stellata* as the only species present in the largest size classes, and demonstrating relatively sustainable levels of regeneration throughout the smaller size classes (Figure 25). There is a prominent dip in the intermediate size classes for *Q. stellata.* All non-oak species are found only in the smallest size classes (5 to 20 cm dbh) and a great majority of trees are less than 15 cm dbh. The distribution of size classes for all species combined forms an inverse J-shaped pattern indicative of positive recruitment, at least among some species. A remarkably similar pattern was found from an eight plot-sample taken in 1989, with the notable exception that *Ulmus rubra* has appeared and *Q. marilandica* has declined in size-class distribution profile (Figure 25).

A comparison of tree basal area and species richness between baseline fire-treatment and fire-free control plots indicates they were nearly identical; average tree density was greater in fire-treatment plots but the difference was not significant (Figure 26). The structural and compositional similarity between fire-treatment and fire-free plots supports the use of samples from the designated control units as fire-free reference plots.

There is some evidence that there have been changes in tree composition at C-O-W since 1989. Eight tree plots (0.05-ha) distributed throughout Units B and C were sampled at that time with nested sapling/shrub and ground cover samples (Taft et al. 1995). Total tree density (stems ≥ 6 cm dbh) was 475/ha with basal area 23.4 m^2/ha, slightly lower than the 2003 sample; however, only five species were recorded. *Quercus stellata* was even more dominant at that time with 74% of IV (298 stems/ha, basal area 20.1 m^2/ha). However, *Q. marilandica* has declined with a reduction in estimated density from 100 to 45 trees/ha and basal area from 2.2 to 0.9 m^2/ha; IV declined from 16% to 8.5%. In contrast, while no *Ulmus rubra* were recorded in the 1989 sample, it now ranks third in IV. More species are expected in a larger sample; however, this difference and the apparent changes in abundance of *Q. marilandica* and *U. rubra* are noteworthy. That *U. rubra* is rather evenly distributed

among sample units (Appendix 4) suggests previous sampling would have detected it had it been at its current level of abundance (74% frequency).

Shrub-Sapling Stratum - Total baseline density of stems in the shrub-sapling stratum at C-O-W was 5,074 stems/ha (4,247 stems/ha in treatment units, 6,480 in control units). Thirty-four shrub-sapling species were recorded from the baseline plots with an average of 7.4/0.01 ha plot. Four species had IV greater than 10 and comprise 48% of the total IV: *Rubus flagellaris, R. pensylvanica, Toxicodendron radicans*, and *Quercus stellata* (Table 12). The brambles (*Rubus* spp.) accounted for 48% of the total density of shrub and sapling species. Four oaks (*Quercus* species) were present with a sum total of 18.4% of the IV. *Q. stellata,* the most common, was estimated to have 311 saplings/ha. Control unit plots had greater stem density and species richness compared to fire-treatment plots and the difference for species richness was significant (Figure 27). Much of the difference in density between treatment and control units is the greater presence of woody vines in the control units (Figure 28), especially *Toxicodendron radicans* which was locally abundant. Shrub-sapling species data from each unit are summarized in Appendix 5.

The 1989 sample estimated only 1,425 stems/ha and much of the difference was in current amounts of *Rubus* spp. and *Toxicodendron radicans*. Sapling-sized *Ulmus rubra* have doubled in density from 1989 with an increase from 50/ha to 104/ha; *Q. stellata* has increased slightly from 250 stems/ha recorded in 1989. In contrast, *Q. marilandica* declined from 250/ha to 126/ha.

Ground-Cover Stratum - Seventy-seven species were recorded in the baseline 324 quadrats (12 quadrats/plot, 27 plots) established at C-O-W for this study (Table 13). Eight species had importance values (IV 200) greater then 5, comprising almost 58% of the IV. In descending rank order of abundance these species were *Parthenocissus quinquefolia, Rubus flagellaris, Eleocharis verrucosa, Quercus stellata, Cinna arundinacea, Agrostis perennans, Carex festucacea,* and *C. glaucodea.* Species richness varied among units from 32 in the 108 quadrats in Unit C to 51 in the 108 quadrats in combined Units D1 and D2; species richness per transect ranged from 7.4 in Unit C to 12.3 in Unit D (Table 10). Species density and percent cover were low throughout, ranging from 1.4 to

2.2. species/quadrat and 20 to 22%, respectively. Ground-cover species data from each unit are summarized in Appendices 6a-6c.

Trifolium reflexum, discovered at C-O-W during 1989 (Taft et al. 1995), was an element of interest in the sampling effort. However, no individuals were sampled within quadrats. Three plants occurred nearby one transect in Unit B (Triad B, Transect 3). However, surveys throughout C-O-W yielded no further plants on which to base a focused monitoring effort.

The ground cover included species representing several habit forms, or physiognomic classes (Figure 29). Most dominant classes, based on summed importance value, were woody vines (primarily *Parthenocissus quinquefolia*), perennial sedges, native shrubs, tree seedlings, perennial forbs, and perennial grasses. The dominant growth forms were not the most diverse. The most diverse, with 31 species, was perennial forbs followed by tree seedlings (n = 15). Adventive shrubs and vines were minor with one species each *(Rosa multiflora* and *Lonicera japonica*, respectively).

An ordination scatterplot (Figure 30), using Principal Components Analysis (PCA) based on occurrences explaining about 65% of the variation in four PCA axes, indicates that the first axis is explained largely by frequency of *Parthenocissus quinquefolia* and other woody shrubs, tree seedlings, and vines (*Rubus flagellaris, Diospyros virginiana, Vitis cinerea, V. riparia*). Species with opposing association to these species include many of the typical flatwoods herbaceous species (e.g., *Dichanthelium acuminatum, Agrostis perennans, Carex glaucodea, Elecharis verrucosa, Cinna arundinacea, Quercus stellata, Carex festucacea*). In other words, plots where these woody vines are common, particularly *P. quinquefolia*, generally lack these typical flatwoods species or they are infrequent compared to plots without the woody vines. Plots from all four C-O-W units are distributed throughout the ordination (including with and without association to *P. quinquefolia*) and reference plots, in particular, occur intermixed with treatment plots supporting their use as fire-free reference plots.

In the baseline, pre-burn condition, species density, species richness, and percent cover were greater in control units (D1 and D2) compared to fire-treatment units (B and C) and the difference for species richness (transect scale) was significant (Figure 31; Table 10). Percent bare ground was slightly greater in the fire-treatment units. Species density is highly and positively correlated to species richness

(r = 0.89, P < 0.0001) and percent cover (r = 0.69, P < 0.0001); species density is negatively correlated to percent bare ground (r = 0.74, P < 0.0001). With regard to interactions between ground-cover and canopy strata, there was no correlation between tree density and the ground cover parameters examined (i.e., richness, species density, percent cover, percent bare ground). Targeted *Parthenium integrifolium* sampling yielded a total ramet count in 2003 of 502 with 342 in censussed treatment plots (1.2% flowering) and 142 in control plots (all sterile).

Post-Fire Responses

Canopy Stratum - Tree species richness, density, and basal area were unchanged in both fire-treatment and fire-free control units (Figure 32) and there was only very slight change among individual units (Table 10). Distribution of size classes among species showed no difference and a comparison of combined species size-class distributions in both treatment and control plots showed no change (Figure 33). Changes among species in the fire-treatment unit were few and minor (Figure 34). Six species increased, four declined, and the remainder were unchanged. The maximum decline was among *Q. marilandica* with an average loss of 3.5 trees per hectare; maximum increase was for *Ulmus rubra* by a similar amount (Figure 34).

Shrub-Sapling Stratum - Species richness and stem density declined in all units at C-O-W between baseline (2003) and post-burn (2004) samples (Figure 35); the differences comparing baseline to post-fire samples were significant in the fire-treatment units (paired t-tests: t = 6.96, df = 16, $P < 0.00001$ and t = 4.95, df = 16, $P = 0.0001$, respectively). Total stem density declined in fire-treatment units B and C from 4,433 to 1,244 and 3,711 to 1,478 stems per hectare, respectively (Table 10). Overall species richness declined from 17 to 14 in Unit B plots and 24 to 20 in Unit C plots. Changes in the control plots were more minor with a decline from 7,078 to 6,022 stems per hectare and from 27 to 25 species.

Only two species, *Vitis cinerea* and *Fraxinus americana*, increased in the fire-treatment units and the increase was very slight; 24 species declined and two (*Q. imbricaria* and *Parthenocissus quinquefolia*) were unchanged. While most species declined in the fire-treatment plots, the magnitude of decline varied widely among species (Figure 36). Species with prominent decline included *Rubus*

fragellaris (76% decline from baseline total), *R. pensylvanicus* (60% decline), *Q. stellata* (68% decline), and *Campsis radicans* (79% decline). Decline occurred among 18 of 25 species in the control plots while there was an increase among four species; the remainder were unchanged. Differences between 2003 and 2004 samples mostly were slight. Prominent increasing species in control plots were *Rosa multiflora* (33%) and *Parthenocissus quinquefolia* (75%); species with major declines were *Rubus pensylvanicus* (31%), *R. flagellaris* (18%), and *Rosa setigera* (42%).

Ground-Cover Stratum - Mean species richness and species density increased in fire treatment plots (Figure 37) and the differences were statistically significant (paired t-test: $t = -5.12$, $df = 16$, $P = 0.0001$, and $t = -5.88$, $df = 16$, $P < 0.0001$, respectively). In contrast, mean species richness and species density declined in the control plots (Figure 37) and the differences were statistically significant (paired t-test: $t = 3.05$, df. $= 9$, $P = 0.014$ and $t = 2.79$, $df = 9$, $P = 0.02$). Final species richness for C-O-W was 84 with 64 species from the 204 treatment quadrats and 47 from the 120 control quadrats. Total richness increased in the burn units from 48 to 56 in Unit B and from 32 to 39 in Unit C (Table 10). Richness declined in the combined control units (units D1 and D2) from 51 to 46 species.

The fire-treatment plots, compared with control plots (Figure 38), had a greater proportion of species that increased in both occurrence number and percent cover (Increasers, 23% vs. 15% of species) and newly emerged species (New Species, 30% vs. 13% of species). A lower proportion of species in treatment plots, compared with control plots, declined in both occurrences and percent cover (Decreasers, 9% vs. 15% of total) or became absent from the sample plots (Extirpated, 16% vs. 21%). Species that increased in occurrences but declined in cover (Mixed I species) were more common in the fire-treatment units while, conversely, species that declined in occurrences but increased in cover (Mixed II species) were more common in the control plots (Figure 38). Prominent increasers in fire-treatment plots were *Acalypha virginica/gracilens* (combined due to determination uncertainty at sample time, but probably mostly *A. virginica*), *Dichanthelium acuminatum, Carex festucacea, Rubus flagellaris, Erechtites hieracifolia, Oxalis stricta/dillenii, Quercus stellata* (seedlings), *Porteranthus stipulaceus*, and *Helianthus strumosus* (Table 14). All these species, with the possible exception of *Oxalis stricta/dillenii* (combined since many were sterile and a positive determination

could not be made in the field), are characteristic flatwoods species. Many New Species (15 of 22) are present in only a single quadrat (Table 14), while the most prominent newly emerged species was *Toxicodendron radicans*. Mixed I model species include some additional characteristic flatwoods species: *Agrostis perennans, Carex albicans, C. glaucodea*, and *Cinna arundinacea*. The most prominent decreasers were woody species *(Parthenocissus quinquefolia* and *Acer saccharinum* seedlings). Species that became absent from sample plots in the treatment units all were scarce in the baseline sample (10 species, all with only one or two occurrences) but include *Q. marilandica* seedlings, *Parthenium integrifolium*, and *Pycnanthemum tenuifolium*, characteristic flatwoods species.

Targeted *Parthenium integrifolium* sampling in 2004 yielded a total ramet count of 552 with 422 (14.3% flowering) in censussed fire-treatment plots and 130 (all sterile) in control plots. This is an increase of 17% in treatment plots and a decline of 8.4% in control plots. Proportion of flowering plants in the fire-treatment plots increased from 1.2% to 14.3%. All ramets in control plots were sterile in both sample years.

In the fire-free control plots, species with the greatest increase were *Agrostis perennans, Fraxinus pennsylvanica*, and *Toxicodendron radicans*. All newly emerged species were present in a single quadrat (Table 15). The species with the greatest decline was *Quercus stellata* (seedlings) with a 44% reduction in frequency. Extirpated species were scarce in the baseline samples, occurring in only one or two quadrats. About 20% of species (vs. about 10% in treatment plots) showed no change in occurrence number (Figure 38).

DISCUSSION

Expected responses of the vegetation strata to fire were only partially met. Contrary to expectations, there were no detected effects of the fire treatments at Chip-O-Will Woods on the canopy stratum. Other studies in *Q. stellata*-dominated communities in Illinois have shown that decline in tree density may not occur until at least a second burn; there also can be a lagging response with mortality continuing after the first post-treatment year (Taft 2003, 2005a). Other studies have shown that multiple fires are necessary to begin to reduce tree density (Peterson and Reich 2001). The lack of

a measured response of trees to a single burn has been reported previously (King 2000). In contrast, in a central Illinois sand forest there was significant mortality following a single burn and mortality continued beyond the initial post-treatment year (Anderson and Brown 1983). Fire intensity evidently varied among these one-burn studies with flames to 5 m reported effecting the sand forest. Fire intensity in the burn at C-O-W was low. Fuel loading and weather conditions appear to be key variables in explaining variation in fire effects (Peterson and Reich 2001). At C-O-W, the primary fuel was oak leaf litter and at the time of the burn leaves were dry at the surface but damp in compressed, underlying layers.

Unit B has been burned twice (March 2001 and March 2004). However, it is unclear whether the previous burn in Unit B also had limited effects on tree density. Unit B baseline tree density is lower than Unit C, but not lower than the fire-free reference units (D1 and D2). Given these ambiguous results, it is not possible to comment with any precision about fire frequency. One intense burn may be more effective at reducing tree density than multiple low-intensity burns.

The apparent stability of *Q. stellata* over the past 14 years indicate conditions remain favorable for its recruitment suggesting current stand structure is not a limiting factor for its regeneration. Although density of *Q. stellata* trees has declined slightly, sapling density increased. The dip in recruitment evident in the 10-to-25 cm dbh size-class range for *Q. stellata* may be related to some past disturbance or a demographic phenomenon (low frequency of acorn mast years). More dramatic changes, however, appear to be underway with the emergence of *Ulmus rubra* and decline in *Q. marilandica*. *Ulmus rubra* was absent from the 1989 tree plots (n = 8) and was scarce in the sapling stratum (Taft et al. 1995). In the 2003 sample, only a few trees exceed 15 cm dbh; most are limited to the smallest two size classes (5-to-15 cm dbh). Also, seedlings of *U. rubra* were scarce in 1989 suggesting the current widespread and common occurrence may be more recent. Increase in *U. rubra* could be from altered environmental conditions that previously limited its establishment, altered disturbance factors that influenced its abundance, or a chance dispersal event that resulted in a large increase in seed input. It seems unlikely that there has been a change in the abiotic environmental conditions at C-O-W, or that disturbance-mediated interactions have been significantly altered. More likely, sometime perhaps 10 to 13 years ago there may have been a large input of *U. rubra* seed into C-O-W leading to its widespread establishment. This could have been the result of a spring storm occurring when seeds in neighboring

forest were dehiscent.

The soil characteristics at C-O-W have similarities to serpentine soils known for low nutrient content and, particularly, low Ca/Mg ratio (Walker 1954). *Q. marilandica* is often associated with sites with nutrient-poor soils (Reich and Hinkley 1980; Hull and Wood 1984), particularly where available water-holding capacity is low such as with sandy textured soils. In a survey of flatwoods soils and vegetation on the Illinoian till plain, *Q. marilandica* was found to be more abundant at sites such as C-O-W with Ca/Mg less than 1.0 and coarse-textured surface soils with low water-holding capacity (Taft et al. 1995). The cause of decline for *Q. marilandica* at C-O-W is unclear. Like most oaks, *Q. marilandica* is considered intolerant of shade and its decline could be related to increased shade and competition for light. However, there is no relationship between current patterns of tree density at C-O-W and *Q. marilandica* abundance that would support competitive replacement as a possibility. There were an estimated 22 standing dead *Q. marilandica* per hectare at C-O-W during 2003 baseline sample and the trees represented a variety of size classes. While substantial, this does not fully account for the greater difference between 1989 and 2003 sample periods suggesting there has been ongoing mortality since 1989. Tree mortality is a characteristic of old-growth forests, but when specific to one species, and across size classes (presumably, within a site with little variation in edaphic properties size classes are at least loosely correlated to age classes) such mortality suggests something other than age is responsible for this decline. The increase in *Ulmus rubra* may be merely coincidental with the decline in *Q. marilandica*; however, perhaps this increased shade has limited the habitat suitability for *Q. marilandica*. Sapling and seedling abundance are much lower than in the 1989 sample. Disease may be another factor, but does not seem to be effecting the *Q. velutina* (another species in the red-oak group) on site. While existing patterns of abundance and overstory structure do not fully support a competition phenomenon, it seems less likely that the environmental conditions previously associated with *Q. marilandica* in flatwoods (i.e., low Ca/Mg ratio or water relations of soil) has been altered at C-O-W.

As expected, there was a demonstrated fire effect on the shrub-sapling stratum, consistent with other studies of single or few burns (Schwartz and Heim 1996; King 2000; Taft 2003, 2005a). There was decline in species richness and stem density in the shrub-sapling stratum throughout C-O-W;

however, the before-after contrasts in the fire-treatment plots were significantly more prominent. Total density returned to levels near the 1989 samples in the fire-treatment units due to major decline in *Rubus* species. These brambles are known to quickly recovery and by clonal spread can respond to multiple fires in flatwoods by eventually exceeding baseline levels (Taft 2005a). Saplings of *Quercus stellata* and *Q. marilandica* declined to a greater degree than *U. rubra*. However, resprouting may lead to a recovery in these oaks; it is unclear how the elm will respond. *Ulmus alata* saplings declined nearly 50% following two fires in a dry barrens (Taft 2003), but trends suggested recovery within about five years to preburn conditions from resprouting stems.

In the ground-cover stratum, the opposing trends for species richness, density, and percent cover in treatment and control plots suggests a fire-effect was responsible for increases in all parameters. Considering the fire effects at C-O-W and BDSP and other studies (Taft 2003, 2005a; Hutchinson et al. 2005), increases in species density, richness, and percent cover appear to be a general feature of ground-cover vegetation following fire in oak woodlands. While there were increases, the low fire intensity in the fire treatments at C-O-W may have limited the response. Although statistically significant, the change in species density was only about one species per quadrat (from 1.6 to 2.6 species). The increase of about 45% in species richness per transect (species number in 12 quadrats) also was significant; however, total richness was only 12.6 species per transect following fire treatment, very low compared with other studies with similar sampling design (e.g., Beaver Dam State Park results [see this report]; Taft 2003). Most of the immediate increase in diversity in oak woodland habitats with fire appears to be from soil-stored taxa. Soil heating in low intensity fires may be insufficient to result in as much heat-stimulated germination in the soil seed bank as would be possible with more intense fires. Fire intensity that is too intense, however, can result in combusting seeds in the surface soil zone.

Studies comparing results from longer-term fire treatments suggest that it can take multiple burns over several years to produce more substantial effects on species composition, diversity, and percent cover (Tester 1989; Peterson and Reich 2001). Decline in these variables in the control plots may not be attributable to the attrition hypothesis since ground-cover species density in 1989 was 1.61 (based on a 200-quadrat sample), below current baseline levels in all of the units. Nevertheless, stasis or gradual decline in these parameters also appears to be a general characteristic of ground-cover

vegetation in unburned oak woodlands.

The greatest Increaser species, those increasing by four or more quadrats, are all characteristic of the habitat (except *Carex annectans,* a widespread facultative wetland species). Several Increaser and New Species at C-O-W also emerged following prescribed fires in a Jefferson County flatwoods (Taft 2005a), including *Carex festucacea, C. caroliniana, C. glaucodea, C. albicans, Acalypha virginica,* and *Dichanthelium acuminatum. Toxicodendron radicans* appeared to increase since it would not have been included in ground-cover samples prior to the burn if the woody stem extended above 50 cm; however, herbaceous basal sprouts from burned stems would indicate increase. Consequently, the apparent dramatic emergence as a new species in the ground-cover stratum is an artifact of sampling criteria.

Trifolium reflexum, an annual or short-lived monocarpic species listed by the Illinois Endangered Species Protection Board at threatened (2005), has been known from C-O-W since 1989 when it was among the ground-cover species sampled in the earlier study (Taft et al. 1995). Plants seen in 1989, 2003, and 2004 all have been in Unit B or in the lawn of a cabin at the edge of Unit B. A few plants occurred adjacent to a baseline transect in Unit B (triad 1B, plot 3) during 2003; however, no plants appeared there in 2004. A single seedling (triad 1C, plot 2) was recorded that appeared to be an extremely diminutive *T. reflexum*. Nearby this transect was seen a *T. reflexum* in bloom with a single flower, rather than the typical cymose cluster, and a mere 1 cm tall. A few other plants were seen scattered throughout the eastern and central portions of Unit B but none were seen in the unburned lawn of the cabin. There have been several studies examining the germination ecology of *T. reflexum* and plants often are found immediately following fire (Taft 2005b). Seeds readily germinate following mechanical scarification of seed coats and fire may serve to scarify seeds that are at the optimal soil depth - not too shallow to be destroyed by fire and not so deep as to avoid seed coat scarification.

A major question in this study at C-O-W was whether the relatively low ground-cover diversity observed throughout much of the site in 1989, and still evident in the newer baseline data (2003), was a natural condition or whether it was a consequence of other factors such as lack of disturbance or too much shade. The latter possibilities suggest that introducing disturbance would yield greater available light and an increase in species richness, assuming there is a viable seed bank of ground cover species.

The former possibility suggests that fire treatment (i.e., introducing a disturbance [fire]) would not yield a dramatic difference. The low-intensity burns in this study make it difficult to draw conclusions about these two possibilities. While the paired differences in ground cover parameters (comparing baseline and post-burn values) were statistically significant, the changes were relatively limited compared to other studies (e.g., Taft 2003, 2005a).

A basis for the consideration that diversity at C-O-W is disturbance mediated is in the results from other studies in flatwoods and barrens that show tree density to be inversely correlated to ground-cover diversity (Taft et al. 1995; Taft and Solecki 2002). However, this pattern is absent in the within-site correlation at C-O-W. It could be that tree density throughout much of the site exceeds optimal levels and is beyond a threshold whereby ground cover diversity is correlated to tree density. There are a few localized, treeless openings within C-O-W that have high percent cover of prairie and savanna species (e.g., *Liatris pycnostachya, Cinna arundinacea, Parthenium integrifolium*, *Baptisia lactea*). While these species also are found generally distributed throughout much of C-O-W, most are sparse outside the openings. Continued fire management may result in increases in these and other shade-limited species if tree density is reduced. However, a characteristic feature of C-O-W is the presence of uncommon cryptogamic species (e.g., *Sphagnum* sp., *Climaceum americanum*, and *Isoetes melanopoda*). It is unclear how these would respond to increased fire frequency and coverage, but there is a risk they could decline.

A basis for the low diversity hypothesis takes into account the location of C-O-W on the leeward side of the Kaskaskia River. At this location, the river would have been a major fire break; consequently, fire may not have had a prominent role in the history of the site. The severe serpentine-like environmental conditions at C-O-W (combining low available water-holding capacity, presence of a claypan, low nutrient availability, and low Ca/Mg ratio) may have resulted in an island effect whereby some species tolerant of these severe glade-like conditions perhaps have been unable to reach the site due to geographic isolation thus limiting diversity at local and site scales.

CONCLUSIONS

In 1989, C-O-W appeared remarkably stable in overstory composition and structure with the

dominant oak species (*Q. stellata* and *Q. marilandica*) demonstrating continued regeneration without trends toward altered stand structure (e.g., strongly skewed size-class distribution). With regard to *Q. stellata*, this remains true: regeneration appears stable but not over-dominant. However, trends for *Q. marilandica* are far less positive and it appears this species not only has become less of a component of the overstory compared to the 1989 sample, but current trends suggest declining future importance. It is unclear if increasing fire frequency will alter these trends. Increasing fire frequency could forestall regeneration by top-killing saplings and producing regrowth basal sprouts. However, opening up the stand, if possible with increased fire management, in the long-term may improve conditions for *Q. marilandica* seedling regeneration. Compared to the 1989 sample data, *Rubus* spp. in the shrub-sapling stratum appear to have increased dramatically on site to become the most frequent species. These clonal shrubs can be fire stimulated to increase and also can be associated with grazing impacts. Neither fire nor livestock grazing have been a part of the recent history of the site except for the single previous burn in 2001 in Unit B. Why these shrubs appear to have increased so dramatically from 1989 samples is unclear.

Ground-cover species diversity remains low at the local scale; however, the species pool at the site scale is diverse with most species characteristic of the habitat. Except for the local openings, these species occur in low density. Continued fire management would most likely result in continued increases in percent cover and species diversity at local scales. None of the increaser species were exclusively ruderal taxa of degraded habitats.

Recommendations with regard to fire frequency depend on specific site management goals. If a central goal is to enhance the diversity of ground-cover species, burns every few years may be sufficient to achieve these goals but may place at risk fire-sensitive cryptogamic species (mosses and quillwort). If the goal is to maintain dominance of *Q. stellata*, in striking contrast to many other flatwoods it appears fire is not currently necessary to achieve this goal. The decline of *Q. marilandica* may be related to stand closure and altered available light. Fire, if at intensity levels adequate to reduce tree density, may improve conditions for seedling regeneration of *Q. marilandica*. Further monitoring is recommended to track progress of management goals. The array of permanent plots established during this study provides this opportunity.

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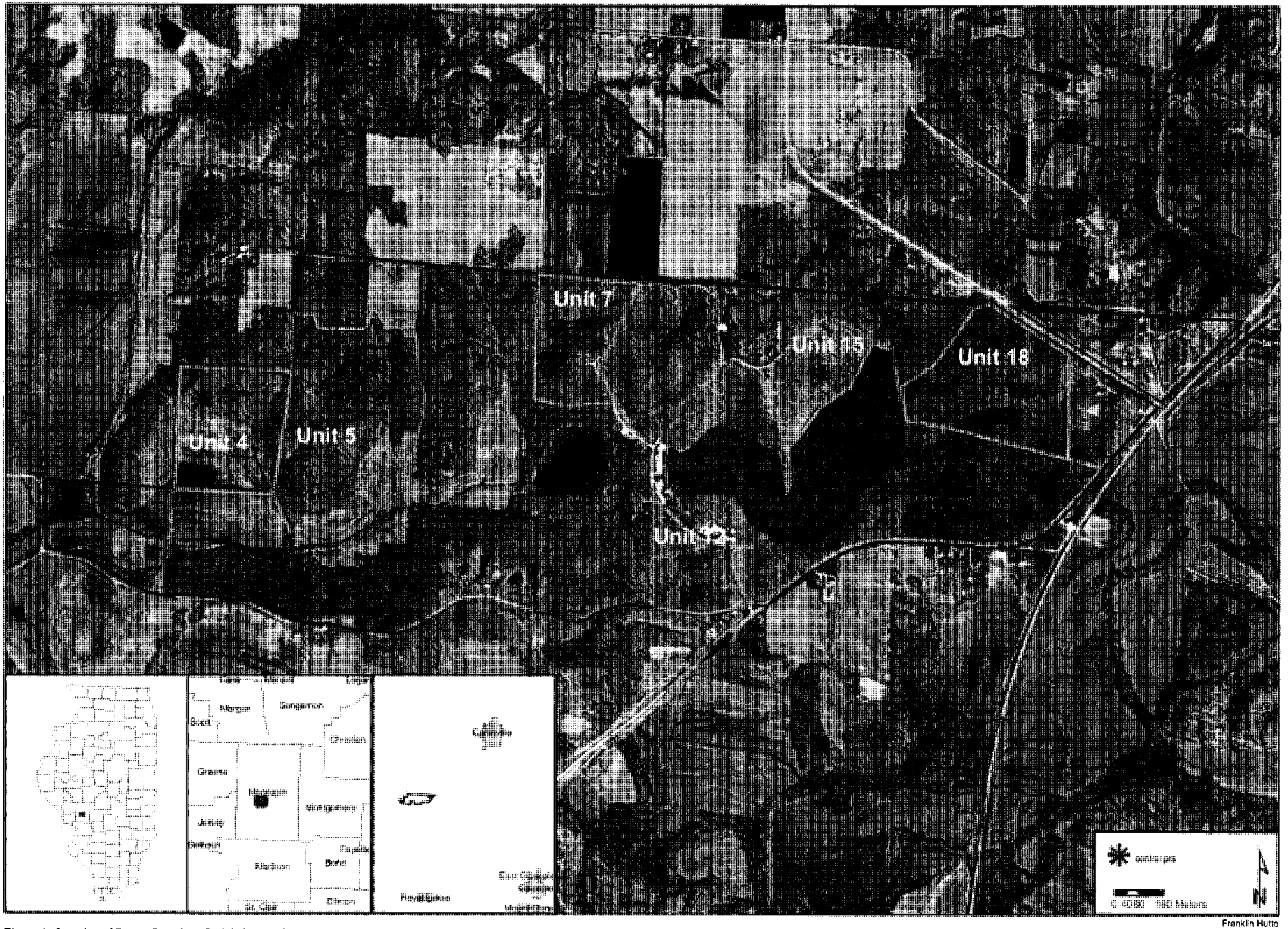


Figure 1. Location of Beaver Dam State Park in Macoupin County and locations of vegetation sample triads in six management units. Units 4, 5, 7, and 15 were fire-treatment units and Units 12 and 18 were fire-free reference units. The plot locations represent center points for a triad of nested vegetation sample plots located 50 m from each point at 120 degree angles.

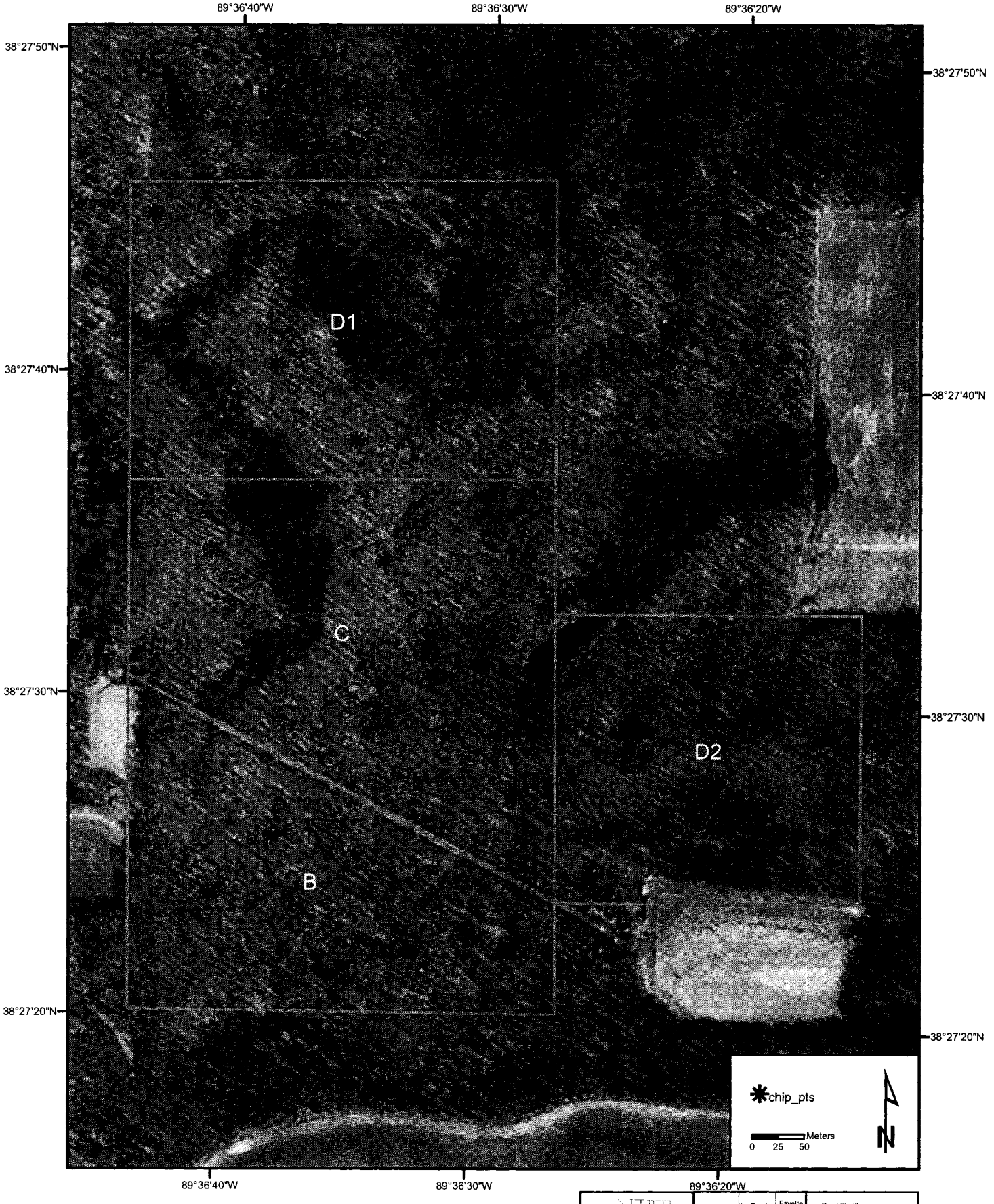


Figure 2. Location of Chip-O-Will Woods in Washington County and locations of vegetation sample triads in the four management units. Units B and C were fire-treatment units and Units D1 and D2 were fire-free reference units. The plot locations represent center points for a triad of nested vegetation sample plots located 50 m from each point at 120 degree angles.

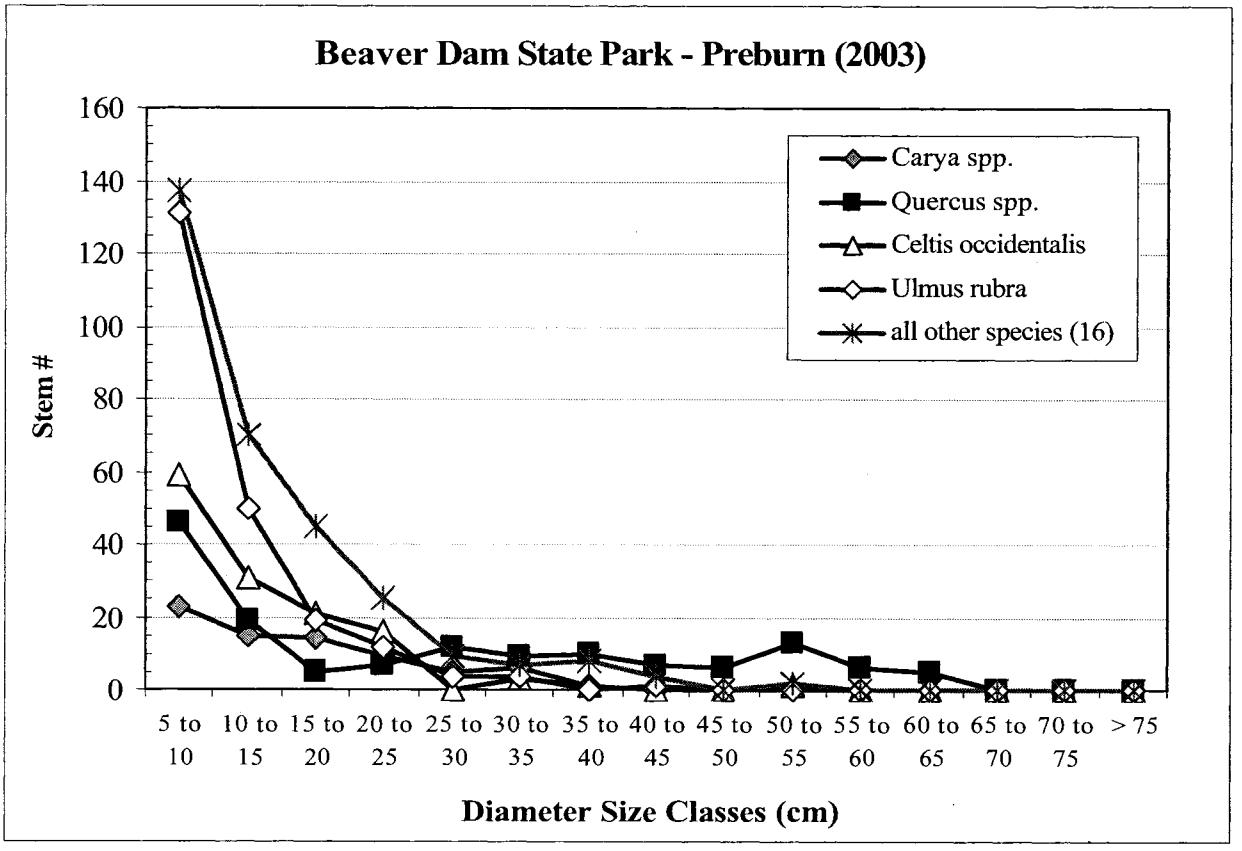


Figure 3. Distribution of tree size classes (stems ≥ 5 cm dbh) from 27 baseline plots in the fire-treatment and fire-free reference plots, Beaver Dam State Park, Macoupin County, Illinois. Total sample area was 1.35 ha.

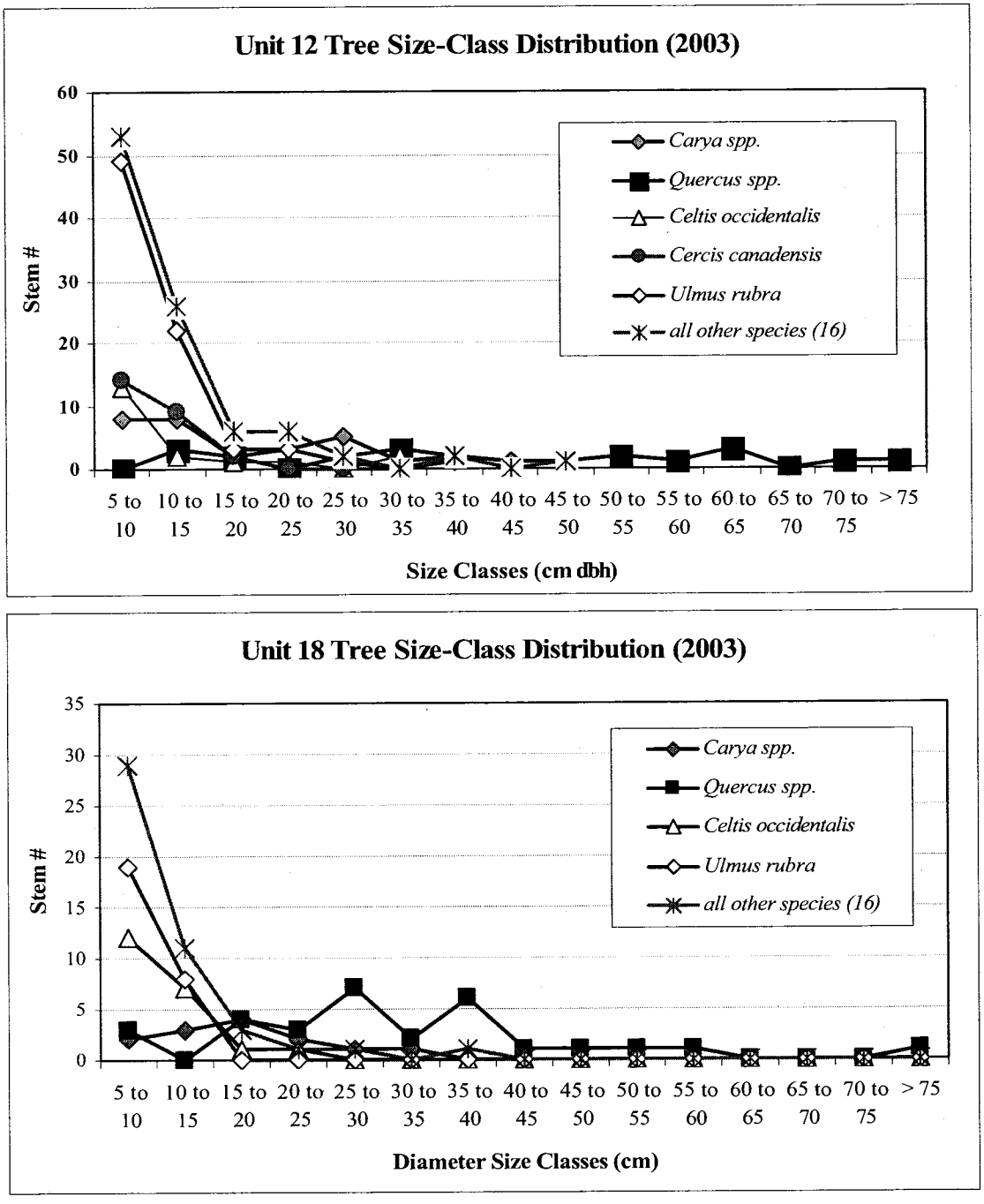
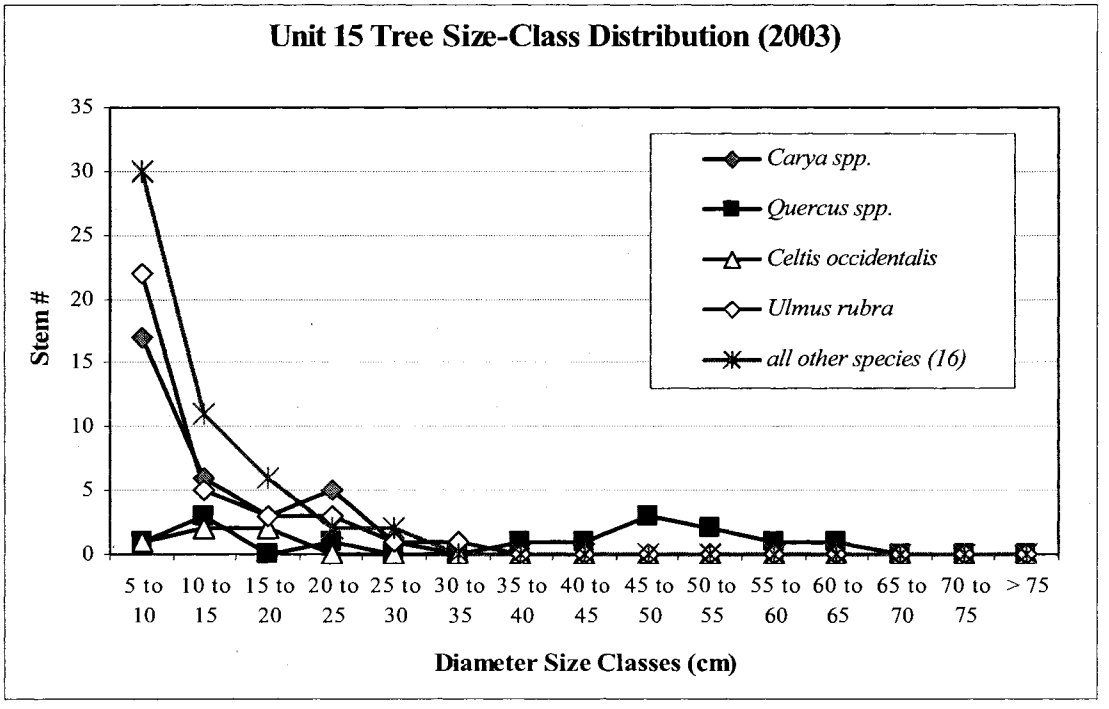


Figure 4a. Distribution of baseline tree size classes in fire-free reference units 12 and 18, Beaver Dam State Park.



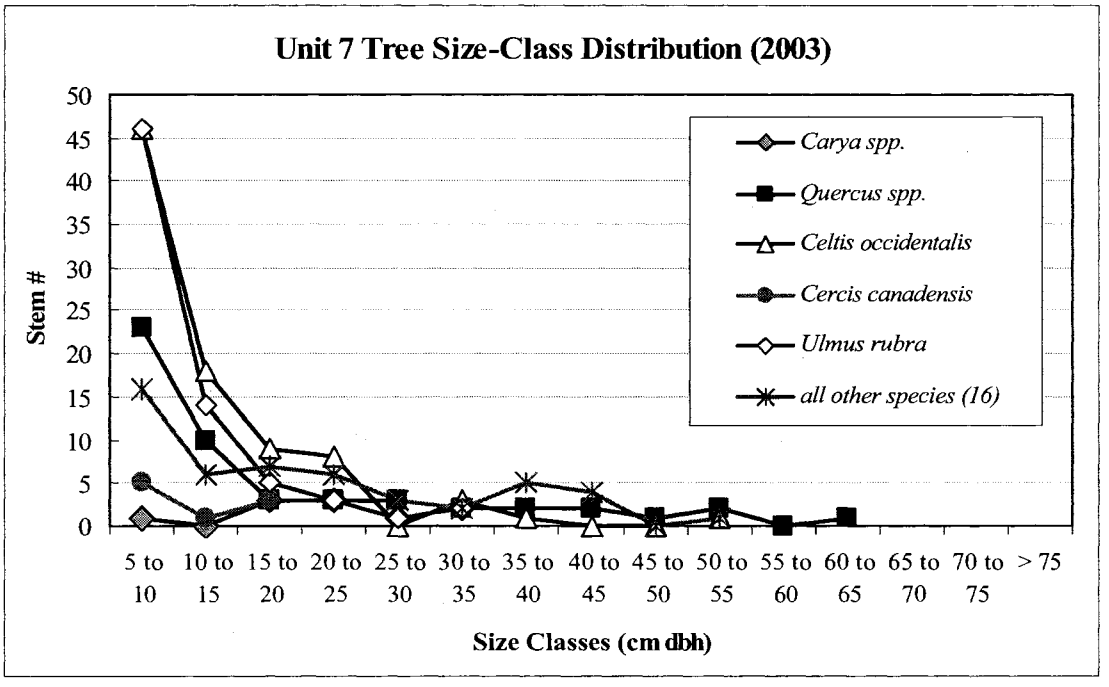


Figure 4b. Distribution of baseline tree size classes in fire-treatment units 7 and 15, Beaver Dam State Park.

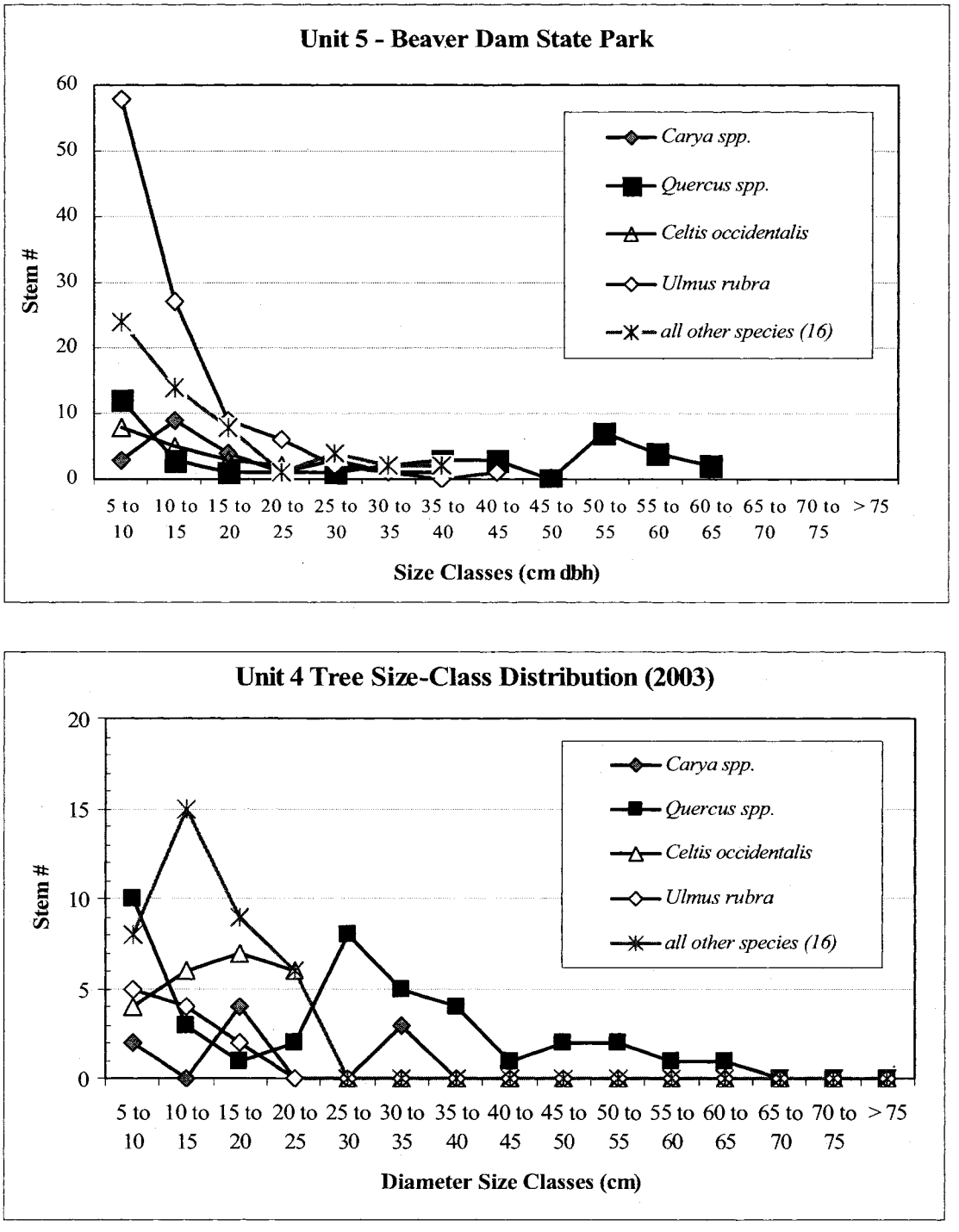


Figure 4c. Distribution of baseline tree size classes in fire-treatment units 4 and 5, Beaver Dam State Park.

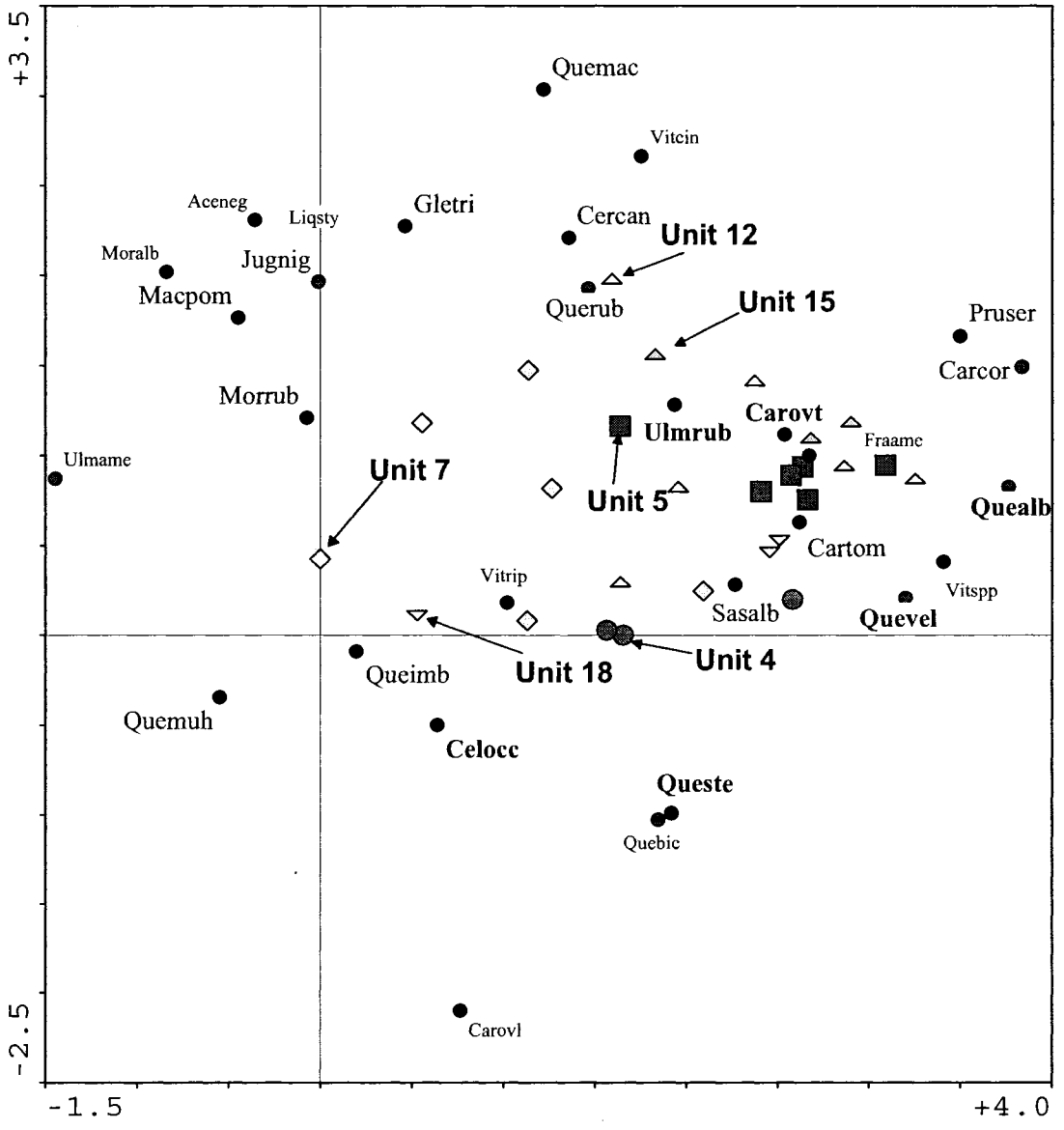


Figure 5. Detrended correspondense analysis (DCA) scatterplot showing plots from previously burned units (dark symbols) and unburned units (open symbols) in tree species ordination space based on importance values (IV 200). Unit names corresponding to representative symbols are shown. **Bold** species names in scatterplot are dominant species. Species acronyms are: Aceneg = *Acer negundo*, Carcor = *Carya cordiformis*, Carovl = *Carya ovalis*, Carovt = *Carya ovata*, Cartom = *Carya tomentosa*, Celocc = *Celtis occidentalis*, Cercan = *Cercis canadensis*, Fraame = *Fraxinus americana*, Gletri = *Gleditsia triacanthos*, Jugnig = *Juglans nigra*, Macpom = *Maclura pomifera*, Moralb = *Morus alba*, Morrub = *Morus rubra*, Pruser = *Prunus serotina*, Quealb = *Quercus alba*, Quebic = *Quercus bicolor*, Queimb = *Quercus imbricaria*, Quemac = *Quercus macrocarpa*, Quemuh = *Quercus muhlenbergii*, Querub = *Quercus rubra*, Queste = *Quecus stellata*, Quevel = *Quercus velutina*, Sasalb = *Sassafras albidum*, Ulmame = *Ulmus americana*, Ulmrub = *Ulmus rubra*, Vitcin = *Vitis cinerea*, Vitrip = *Vitis riparia,* Vitspp = *Vitis* spp. Beaver Dam State Park.

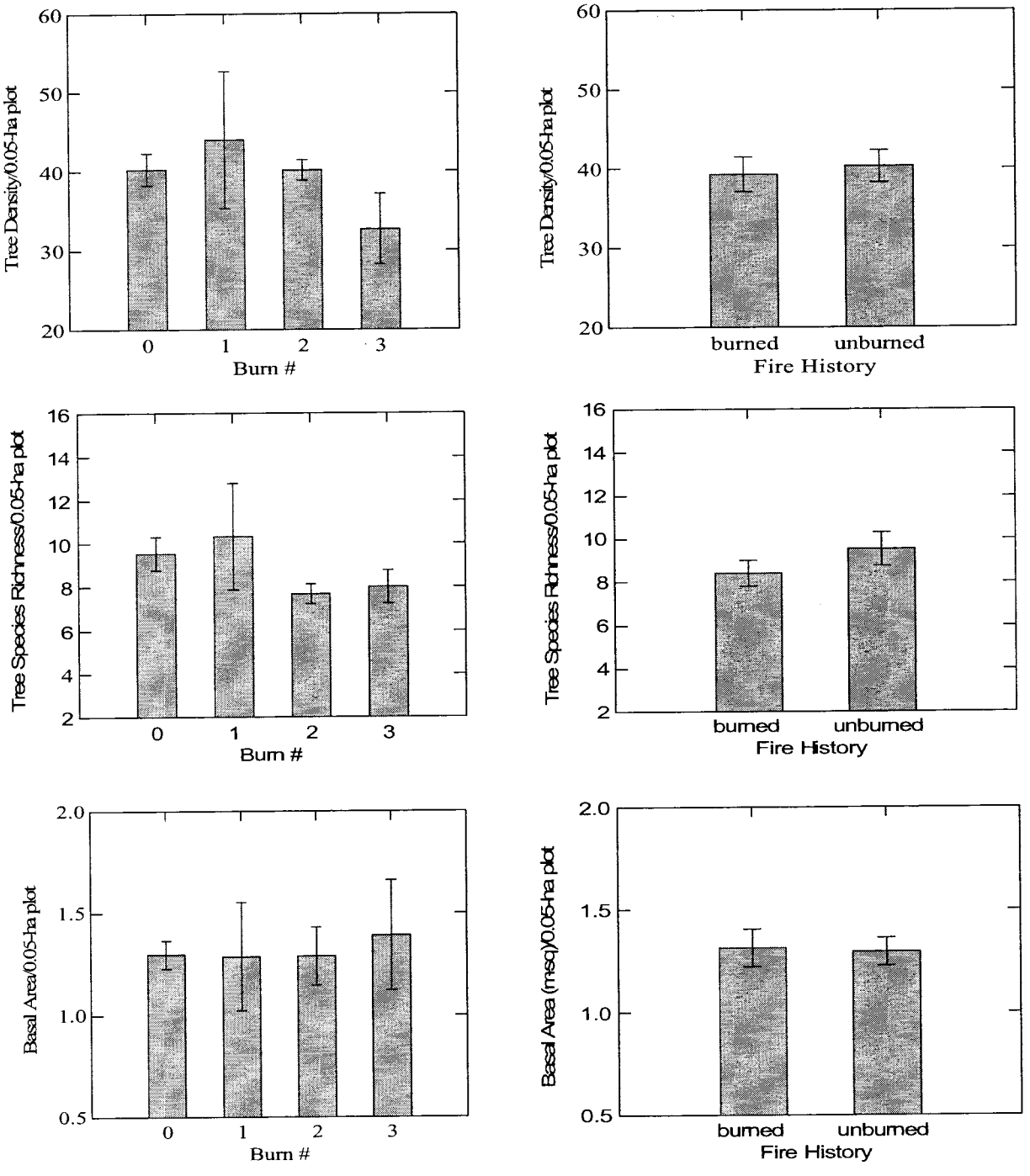


Figure 6. Baseline (2003) parameters of the canopy stratum comparing units according to recent burn frequency and overall recent fire history (two-sample comparisons in right column). All differences non-significant. Data from Beaver Dam State Park.

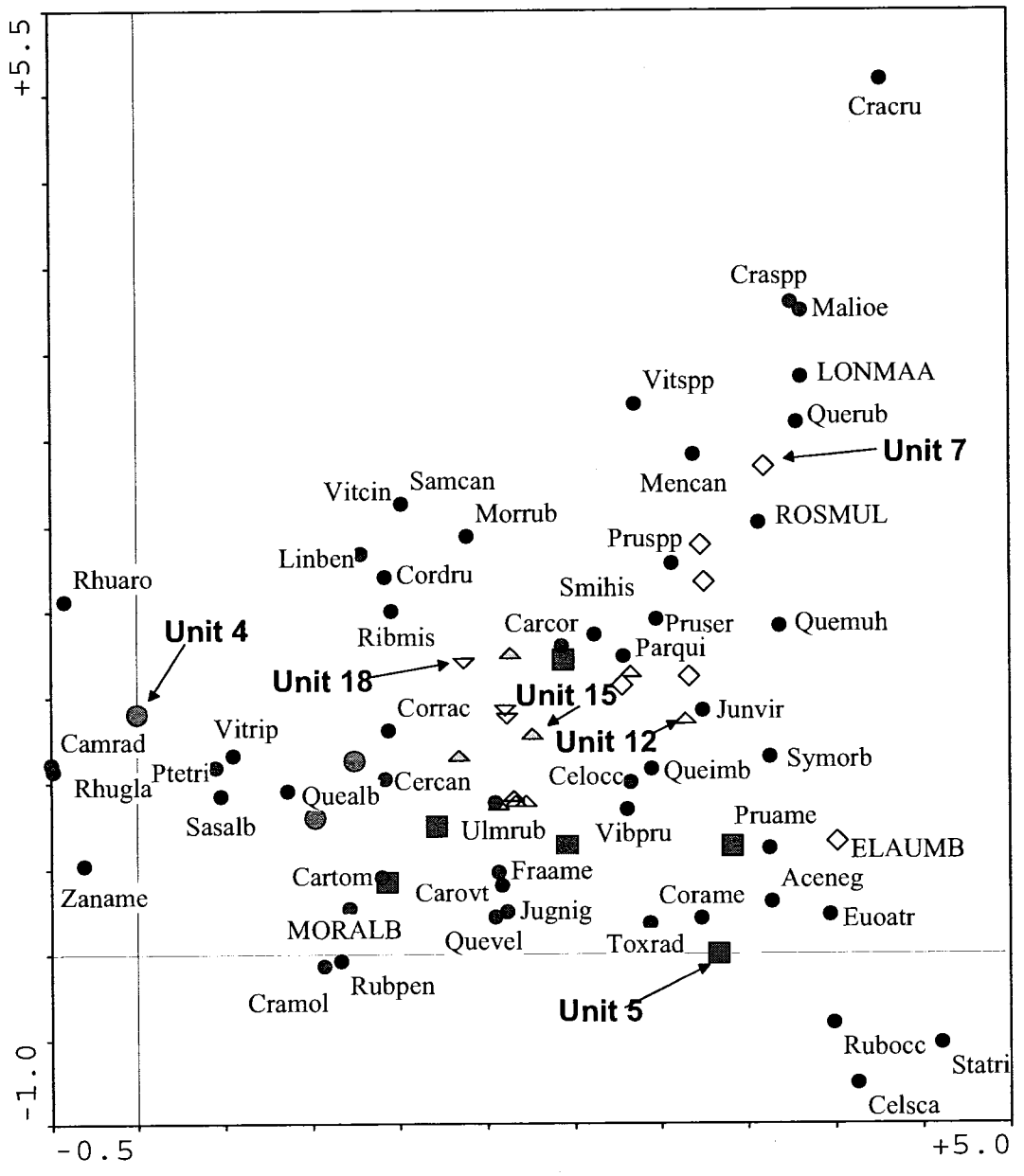


Figure 7. Detrended correspondense analysis (DCA) scatterplot of baseline shrub-sapling density data. Open symbols are previously unburned plots; burn plots are indicated by shaded symbols. Each unit is represented by a distinct symbol. Exotic species are shown in CAPS. Species acronyms are:

Aceneg = *Acer negundo*
Camrad = *Campsis radicans*
Carcor = *Carya cordiformis*
Carovt = *Carya ovata*
Cartom = *Carya tomentosa*
Celocc = *Celtis occidentalis*
Celsca = *Celastris scandens*
Cercan = *Cercis canadensis*
Corame = *Corylus americana*
Cordru = *Cornus drummondii*
Corrac = *Cornus racemosa*
Cracru = *Crataegus crus-galli*

Figure 7 caption continued.

Cramol = *Crataegus mollis*
Craspp = *Crataegus* spp.
ELAUMB = *Elaeagnus umbellata*
Euoatr = *Euonymus atropurpurea*
Fraame = *Fraxinus americana*
Jugnig = *Juglans nigra*
Junvir = *Juniperus virginiana*
Linben = *Lindera benzoin*
LONMAA = *Lonicera maackii*
Malioe = *Malus ioensis*
Mencan = *Menispermum canadense*
MORALB = *Morus alba*
Morrub = *Morus rubra*
Parqui = *Parthenocissus quinquefolia*
Pruame = *Prunus americana*
Pruser = *Prunus serotina*
Pruspp - *Prunus* spp.
Ptetri = *Ptelia trifoliata*
Quealb = *Quercus alba*
Queimb = *Quercus imbricaria*
Quemuh = *Quercus muhlenbergii*
Querub = *Quercus rubra*
Quevel = *Quercus velutina*
Rhuaro = *Rhus aromatica*
Rhugla = *Rhus glabra*
Ribmis = *Ribes missouriense*
ROSMUL = *Rosa multiflora*
Rubocc = *Rubus occidentalis*
Rubpen = *Rubus pensylvanica*
Sasalb = *Sassafras albidum*
Smihis = *Smilax hispida*
Statri = *Staphylea trifolia*
Symorb = *Symphoricarpos orbiculatus*
Toxrad = *Toxicodendron radicans*
Ulmrub = *Ulmus rubra*
Vibpru = *Viburnum prunifolium*
Vitcin = *Vitis cinerea*
Vitspp = *Vitis* spp.
Zaname = *Zanthoxylem americanum.*

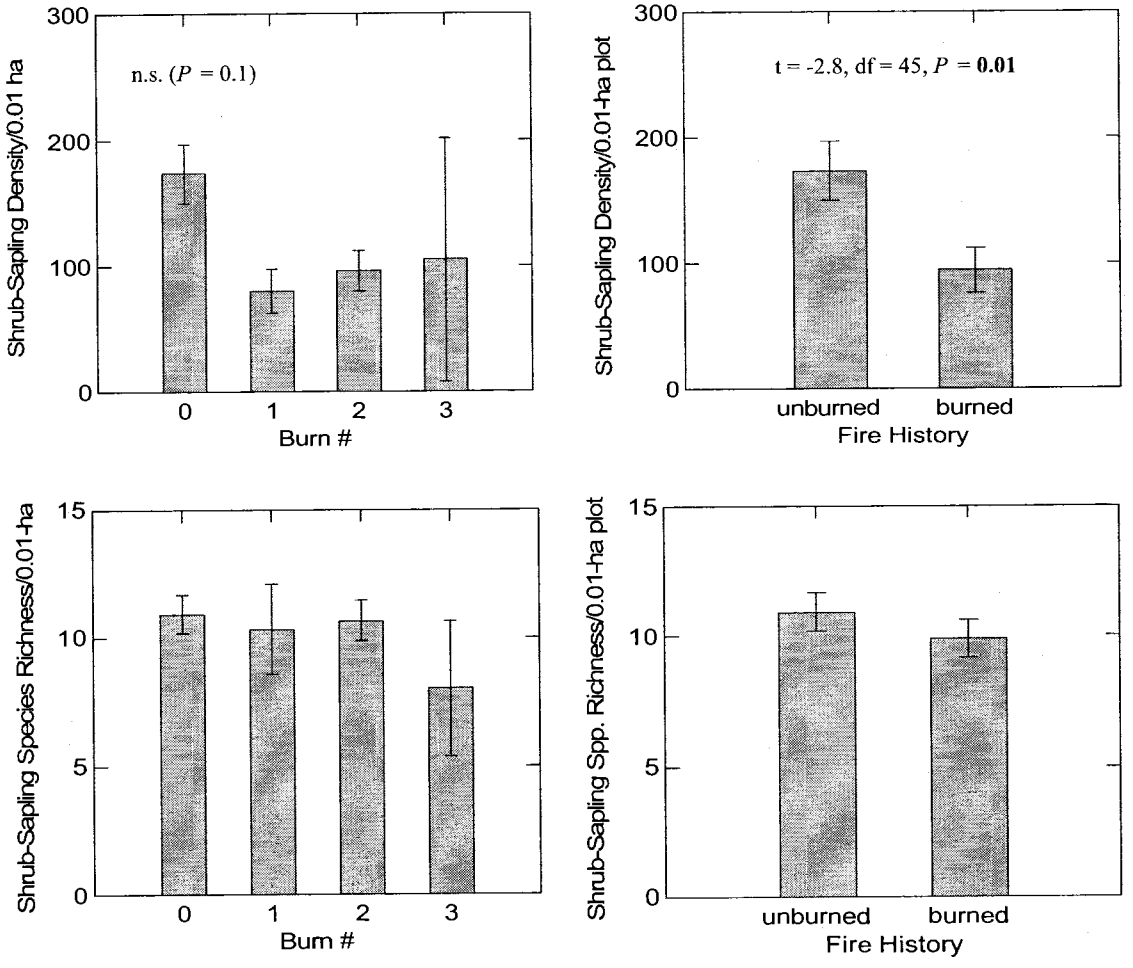


Figure 8. Baseline (2003) parameters of the shrub-sapling stratum comparing units according to number of recent burns and overall recent fire history (two-sample comparisons in right column). Data from Beaver Dam State Park.

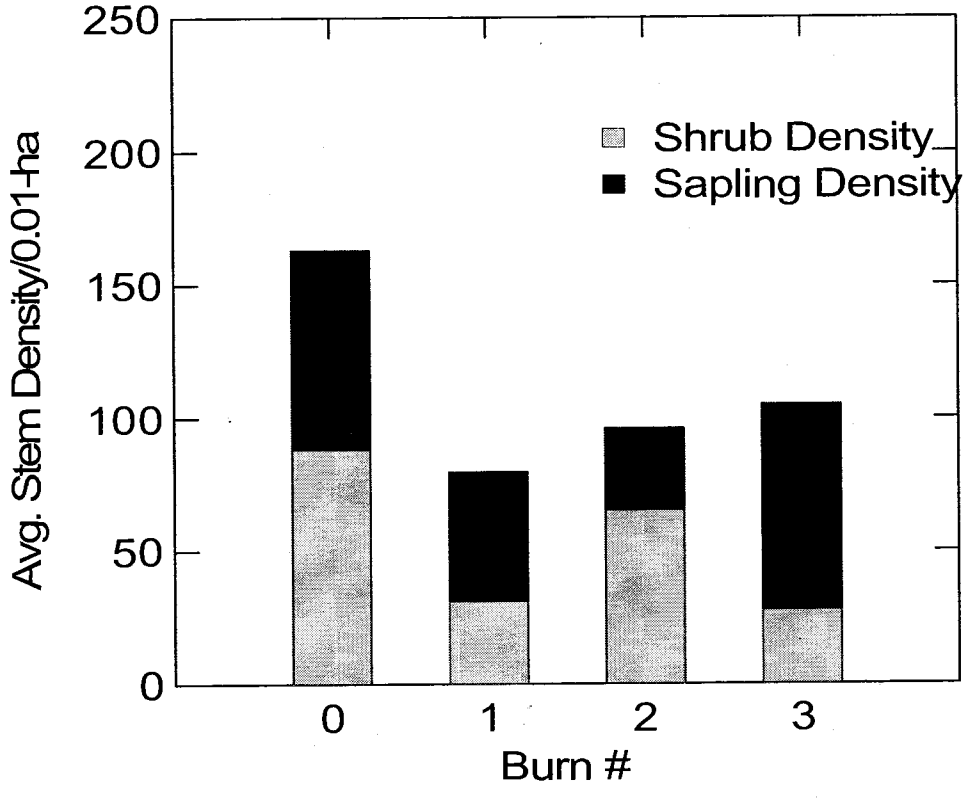


Figure 9. Comparison of shrub and sapling species density according to baseline fire-frequency classes, Beaver Dam State Park.

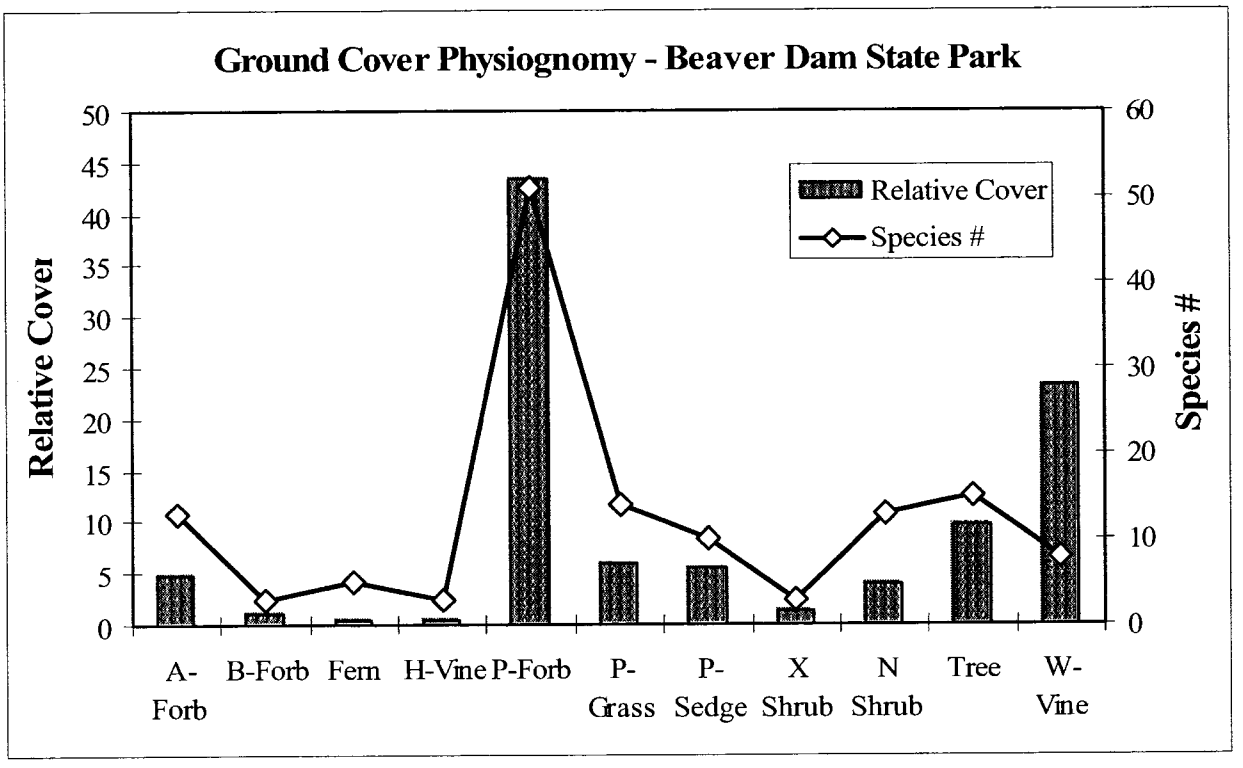


Figure 10. Distribution of relative cover and species richness among ground-cover species physiognomic classes in baseline (2003) sample data at Beaver Dam State Park. A = annual, B = biennial, H = herbaceous, P = perennial, X = exotic, N = native, W = woody.

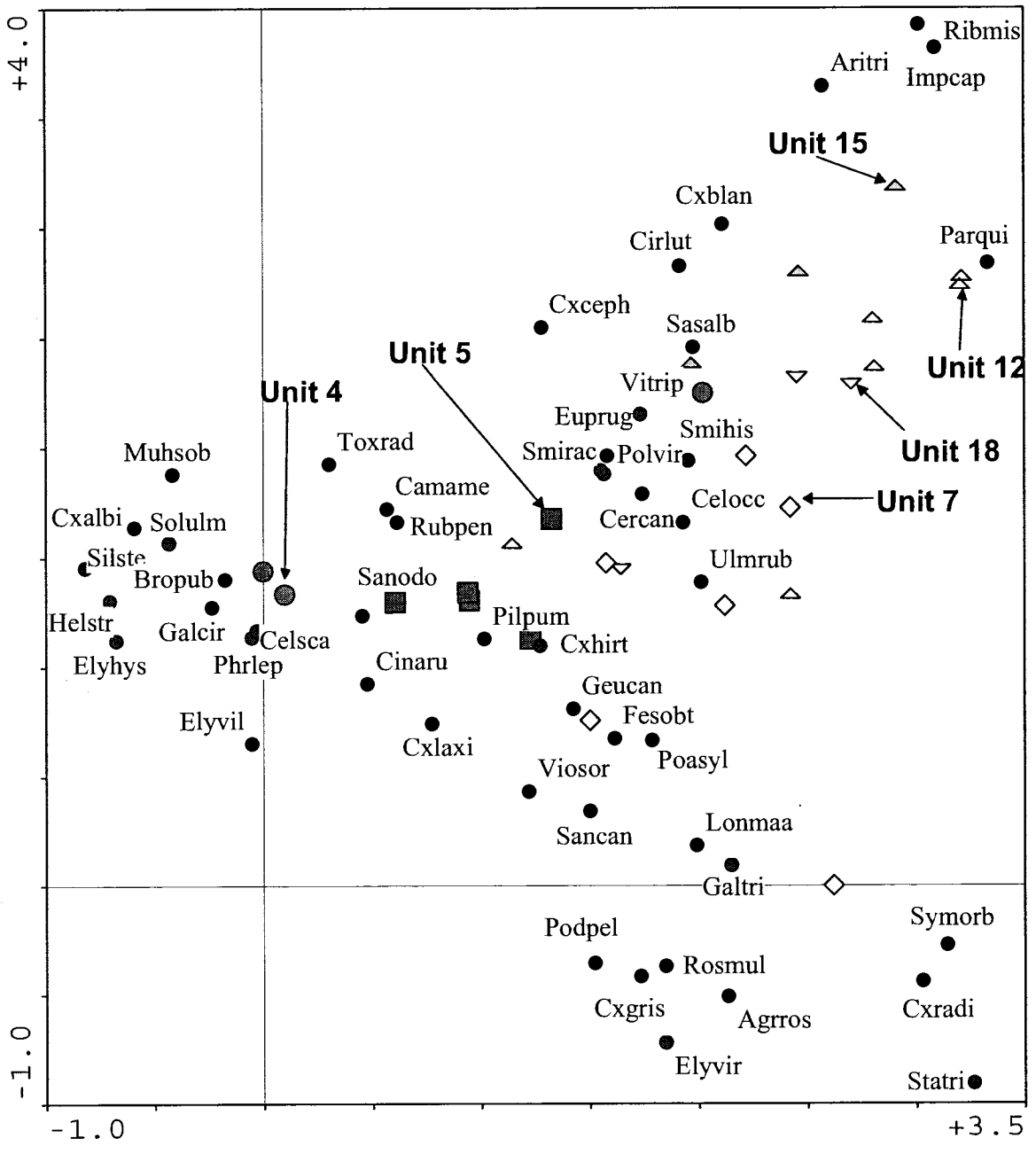


Figure 11. Detrended correspondense analysis (DCA) scatterplot of baseline ground-cover species based on percent cover of the 50 top-ranking species. Previously burned plots are shown in solid symbols; unburned plots shown with open symbols. Species acronyms are listed below.

Agrros	*Agrimonia rostellata*
Aritri	*Arisaema triphyllum*
bropub	*Bromus pubescens*
camame	*Campanula americana*
Celocc	*Celtis occidentalis*
Celsca	*Celastris scandens*
Cercan	*Cercis canadensis*
Cinaru	*Cinna arundinacea*
Cirlut	*Circaea lutetiana*
cxalbi	*Carex albicans*
Cxblan	*Carex blanda*
Cxceph	*Carex cephalophora*
Cxgris	*Carex cf. grisea*
Cxhirt	*Carex hirtifolia*

Figure 11 caption continued.

Cxlaxi	*Carex laxiflora*
Cxradi	*Carex radiata*
Elyhys	*Elymus hystrix*
Elyvil	*Elymus villosus*
Elyvir	*Elymus virginicus*
Euprug	*Eupatorium rugosum*
Fesobt	*Festuca obtusa*
Galcir	*Galium circaezans*
Galtri	*Galium triflorum*
Geucan	*Geum canadense*
Helstr	*Helianthus strumosus*
Impcap	*Impatiens capensis*
Lonmaa	*Lonicera maackii*
Muhsob	*Muhlenbergia sobolifera*
Parqui	*Parthenocissus quinquefolia*
Phrlep	*Phryma leptostachya*
Pilpum	*Pilea pumila*
Poasyl	*Poa sylvestris*
Podpel	*Podophyllum peltatum*
Polvir	*Polygonum virginicum*
Ribmis	*Ribes missouriense*
Rosmul	*Rosa multiflora*
Rubpen	*Rubus pensylvanicus*
Sancan	*Sanicula canadensis*
Sanodo	*Sanicula odorata*
Sasalb	*Sassafras albicans*
Silste	*Silene stellata*
Smihis	*Smilax hispida*
Smirac	*Smilacina racemosa*
Solulm	*Solidago ulmifolia*
Statri	*Staphylea trifolia*
Symorb	*Symphoricarpos orbiculatus*
Toxrad	*Toxicodendron radicans*
Ulmrub	*Ulmus rubra*
Viosor	*Viola sororia*
Vitrip	*Vitis riparia*

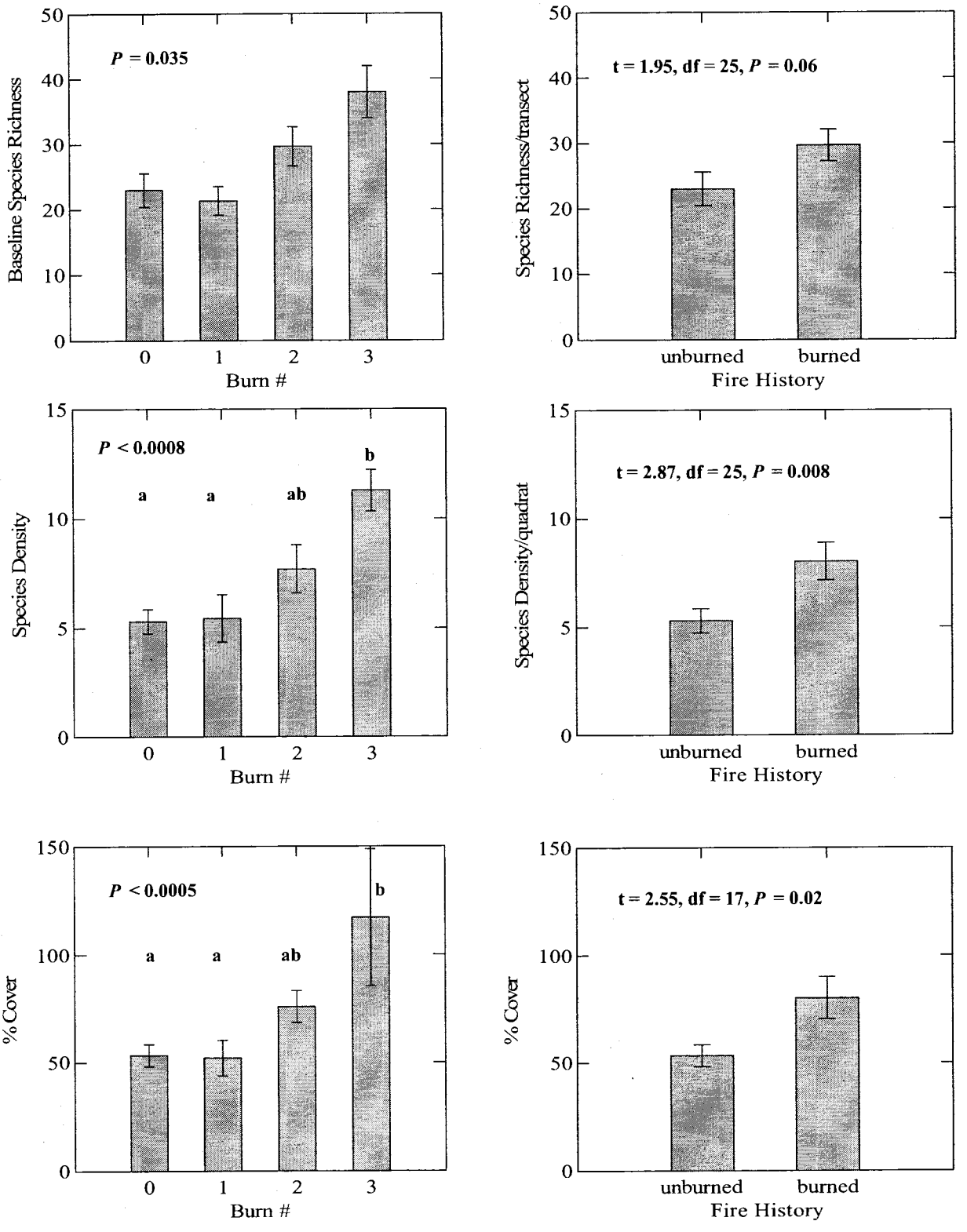


Figure 12. Baseline ground-cover data from Beaver Dam State Park comparing parameters of species richness, species density, and % cover among fire-frequency classes and between burned and unburned units.

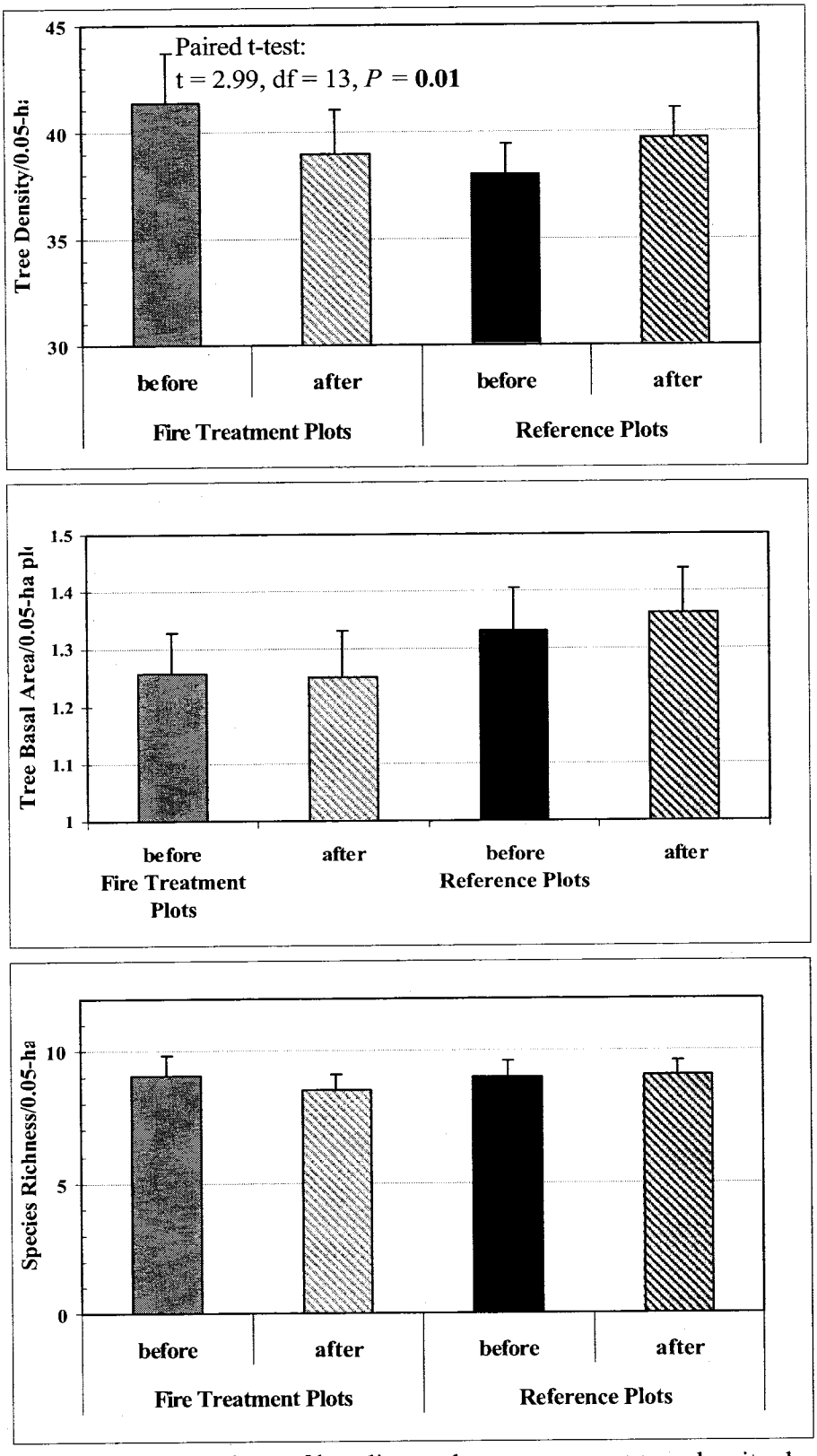
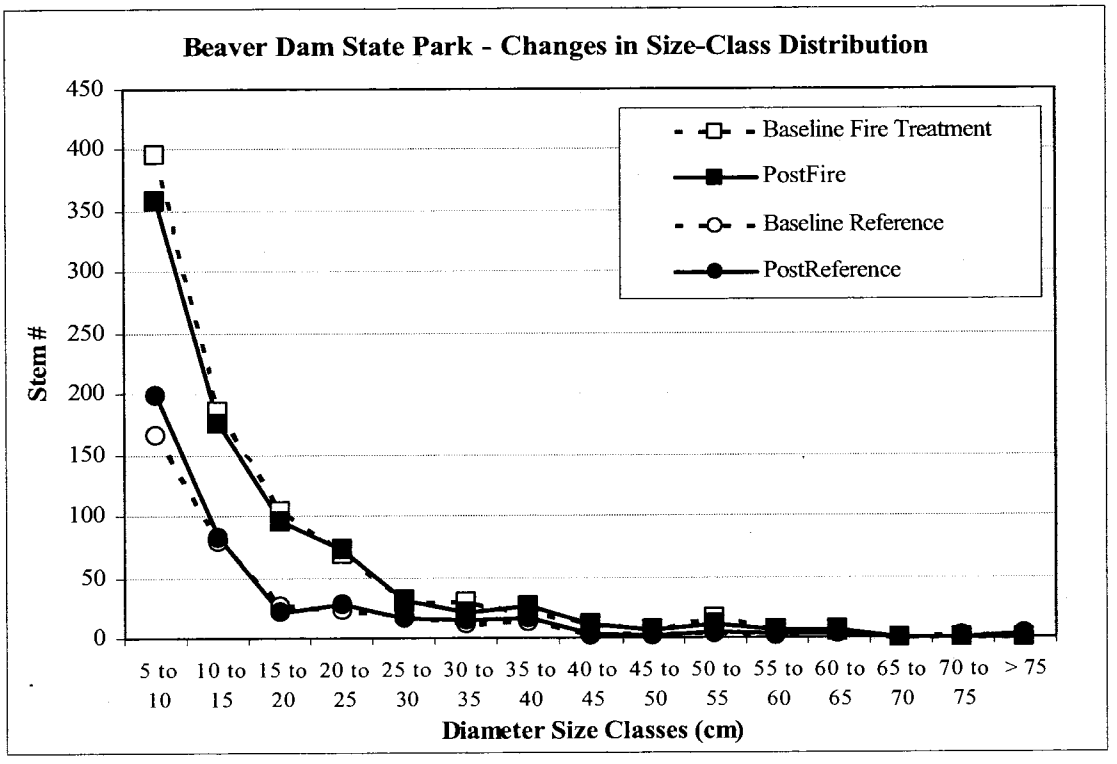


Figure 13. Comparison of baseline and post-treatment tree density, basal area, and species richness in fire-treatment and reference plots at Beaver Dam State Park. Statistically significant differences are shown; others comparisons are not different.



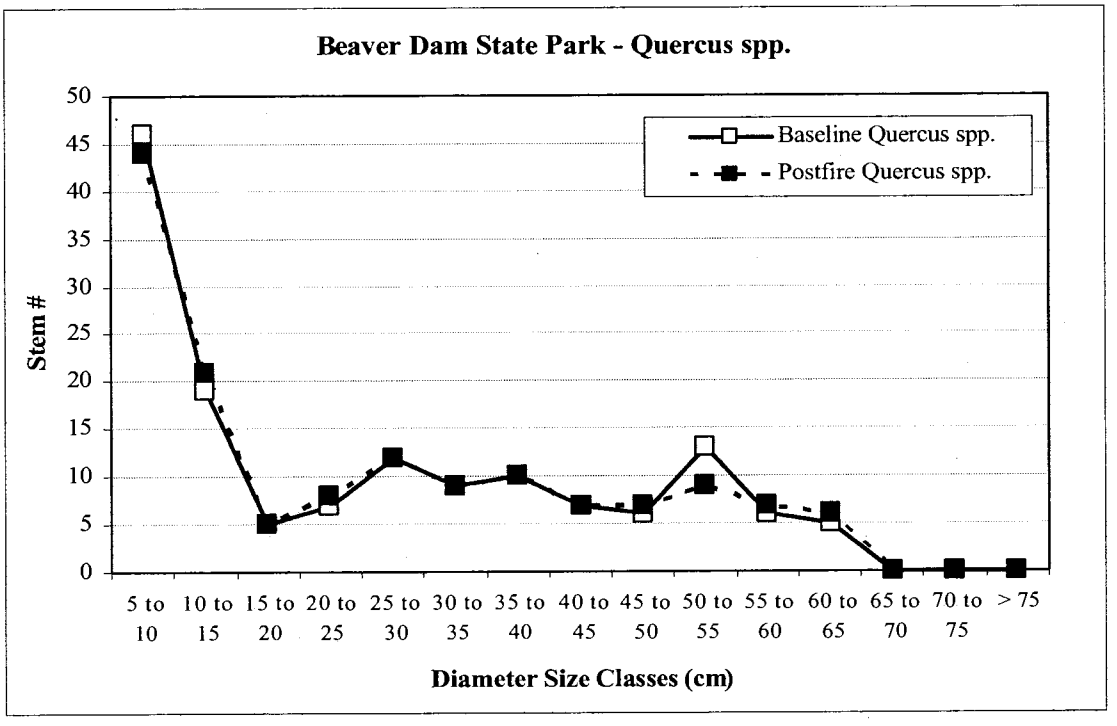


Figure 14. Change in the distribution of size classes among trees, all species combined and *Quercus* species, comparing baseline and post-fire samples.

Figure 15. Changes in density among trees comparing baseline and post-treatment in fire-treatment plots at Beaver Dam State Park.

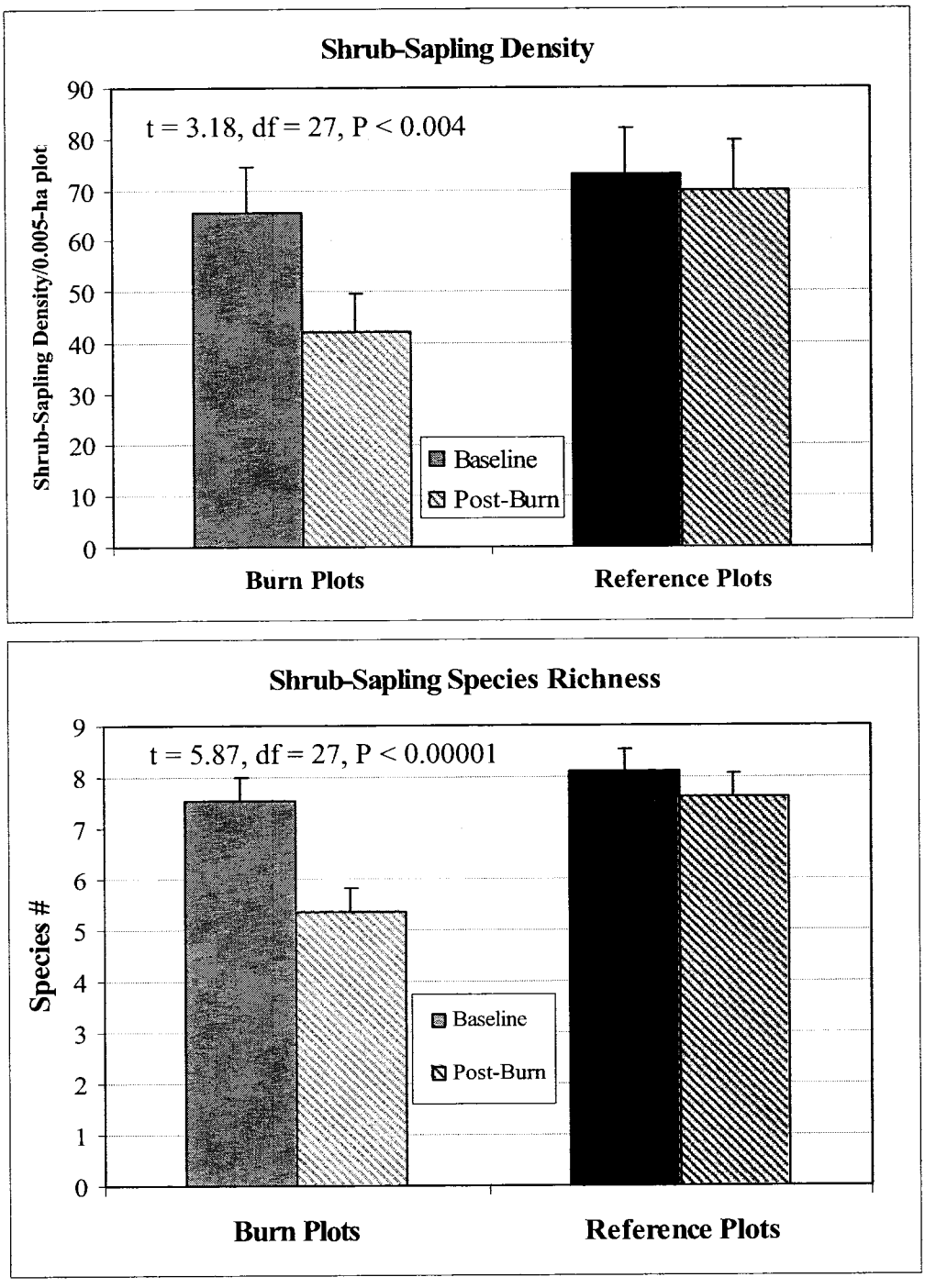


Figure 16. Change in shrub-sapling density and species richness in fire-treatment and reference plots at Beaver Dam State Park, comparing baseline and post-treatment samples. Statistically different comparisons are shown.

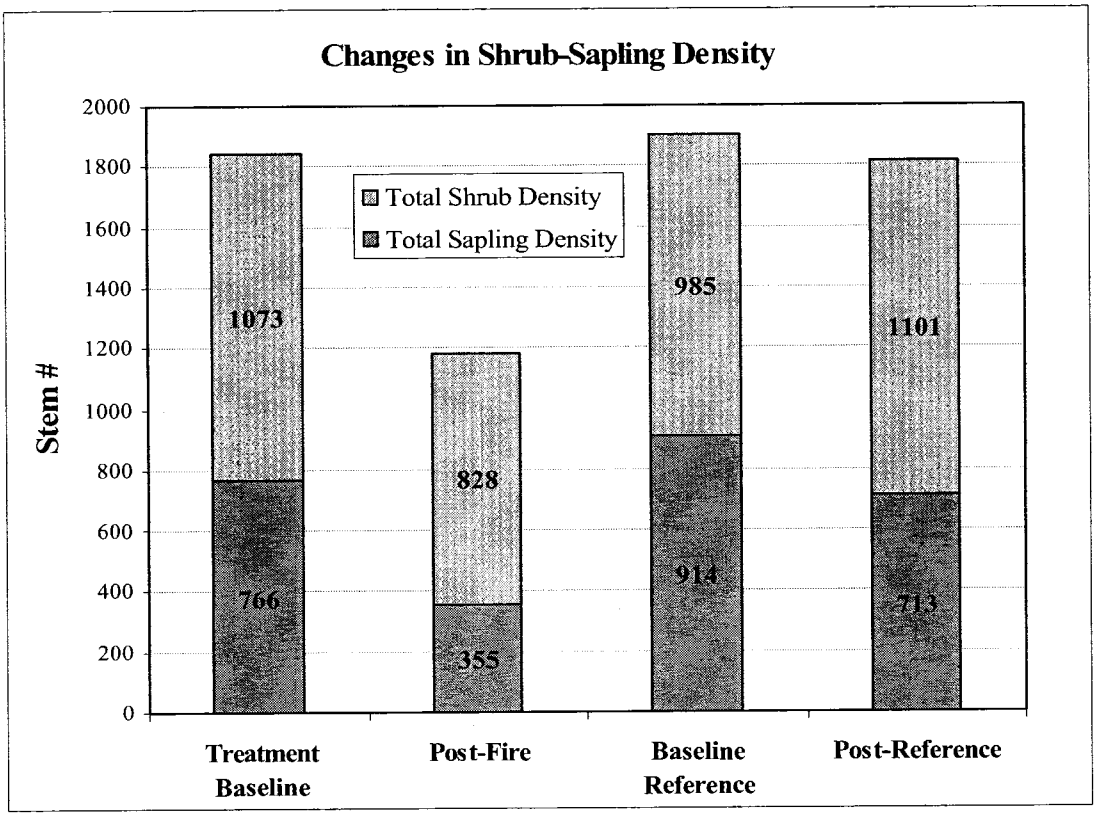


Figure 17. Changes in the proportion of shrub and sapling species in fire-treatment and reference plots at Beaver Dam State Park comparing baseline and post-treatment samples.

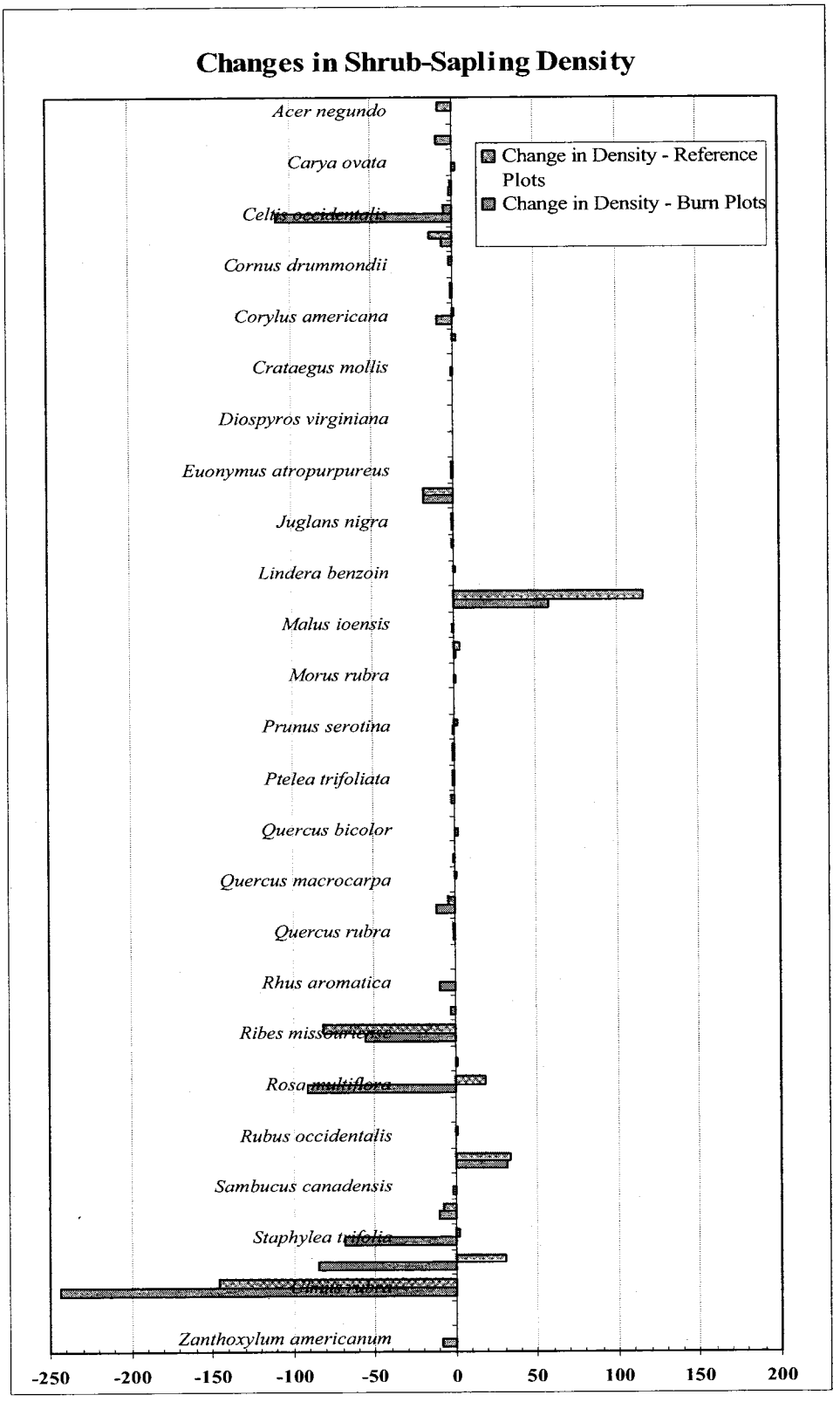


Figure 18. Changes in density of shrub-sapling species at Beaver Dam State Park comparing baseline and post-treatment samples in fire-treatment and reference units.

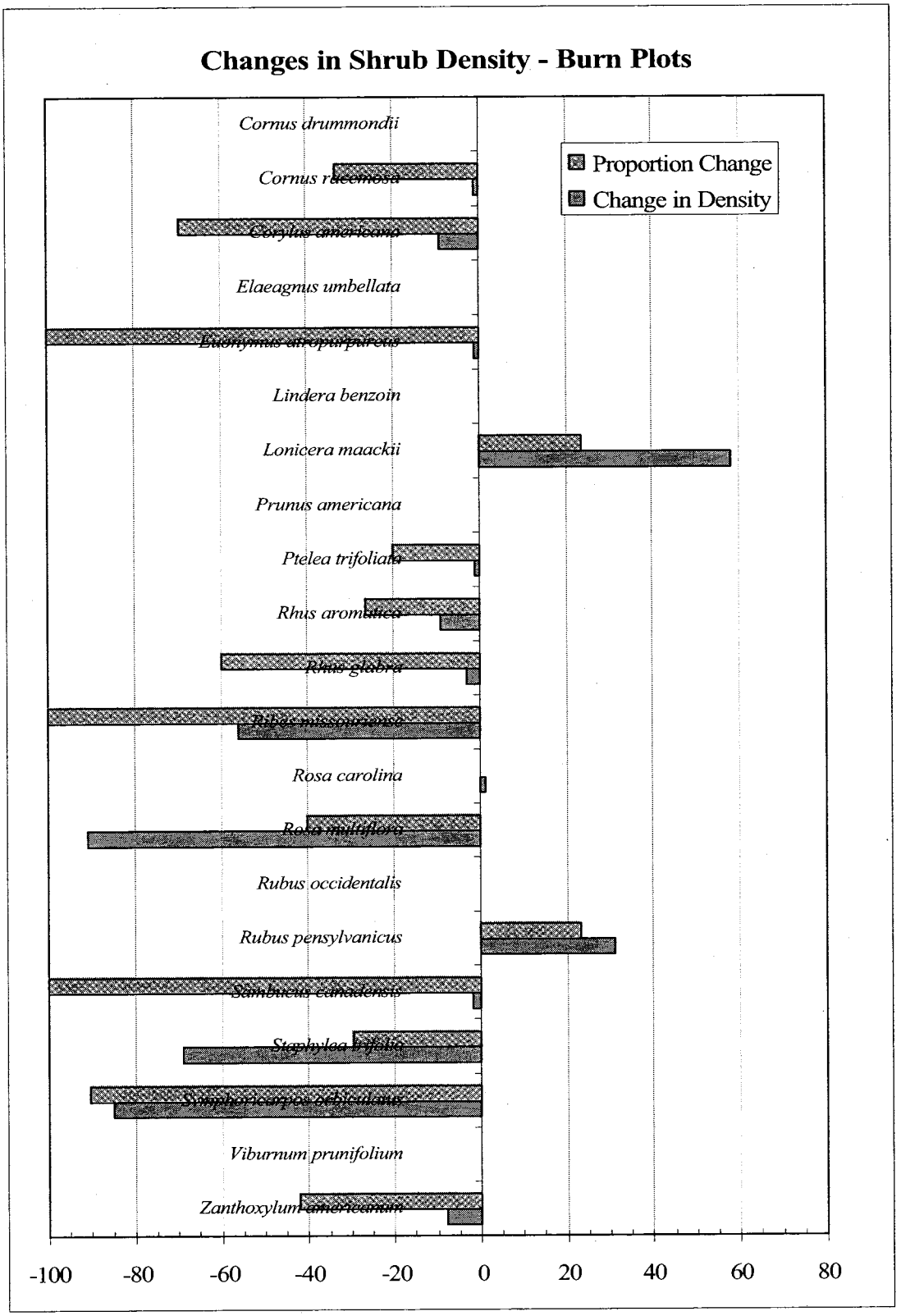


Figure 19. Changes in density and proportion of stems among shrub species in the fire-treatment plots at Beaver Dam State Park.

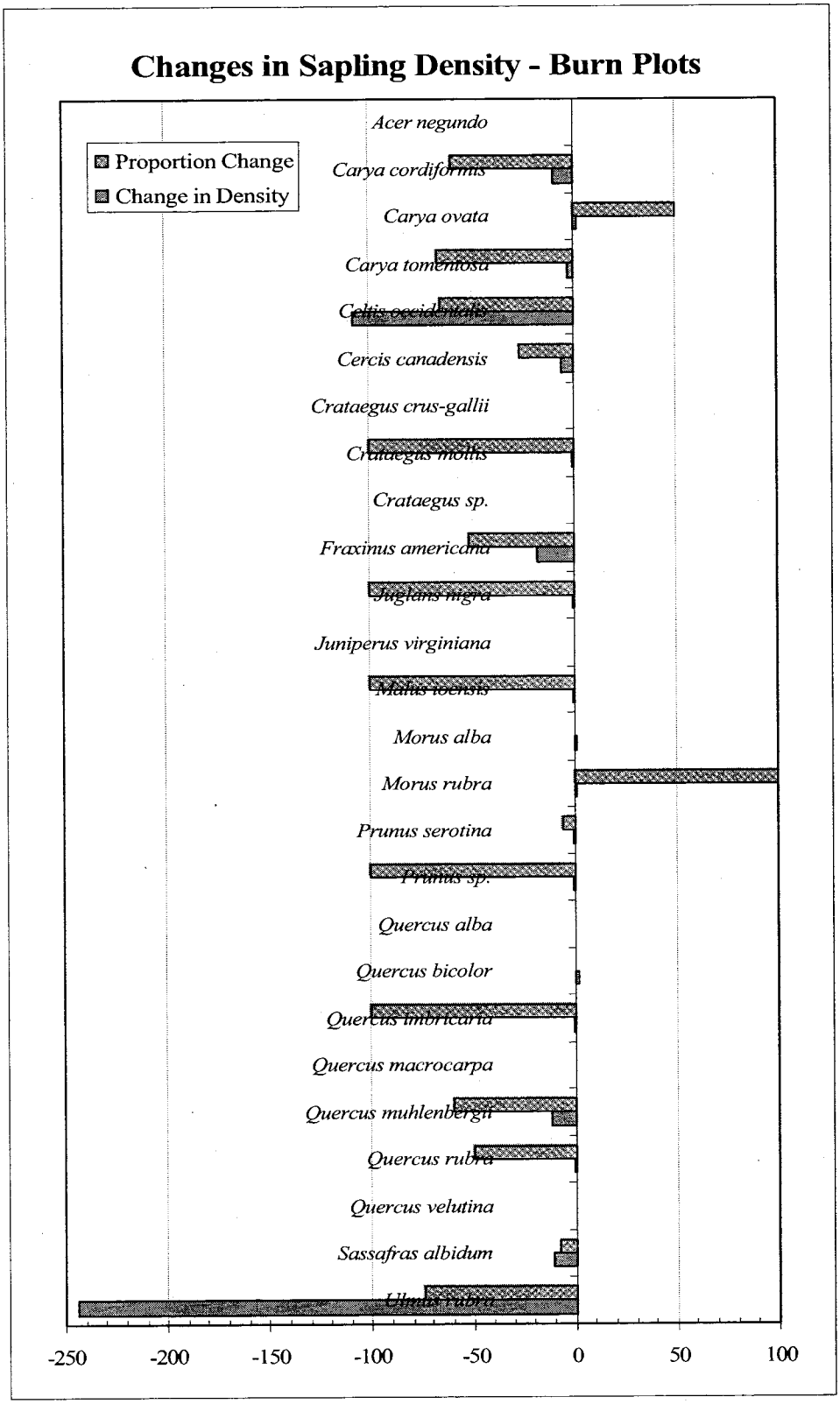


Figure 20. Changes in density and proportion of stems among sapling species in the fire-treatment plots at Beaver Dam State Park.

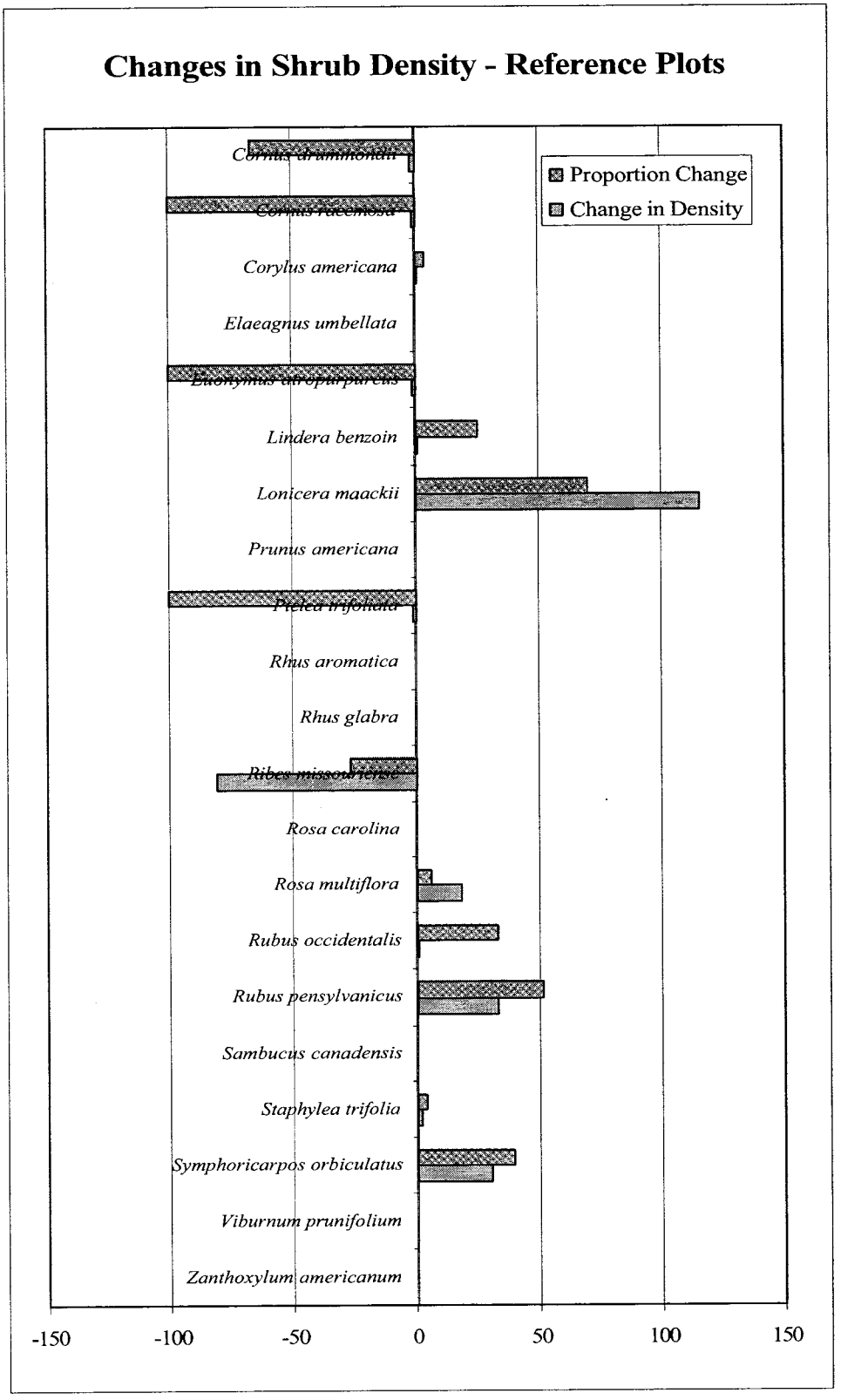


Figure 21. Changes in density and proportion of stems among shrub species in the fire-free reference plots at Beaver Dam State Park.

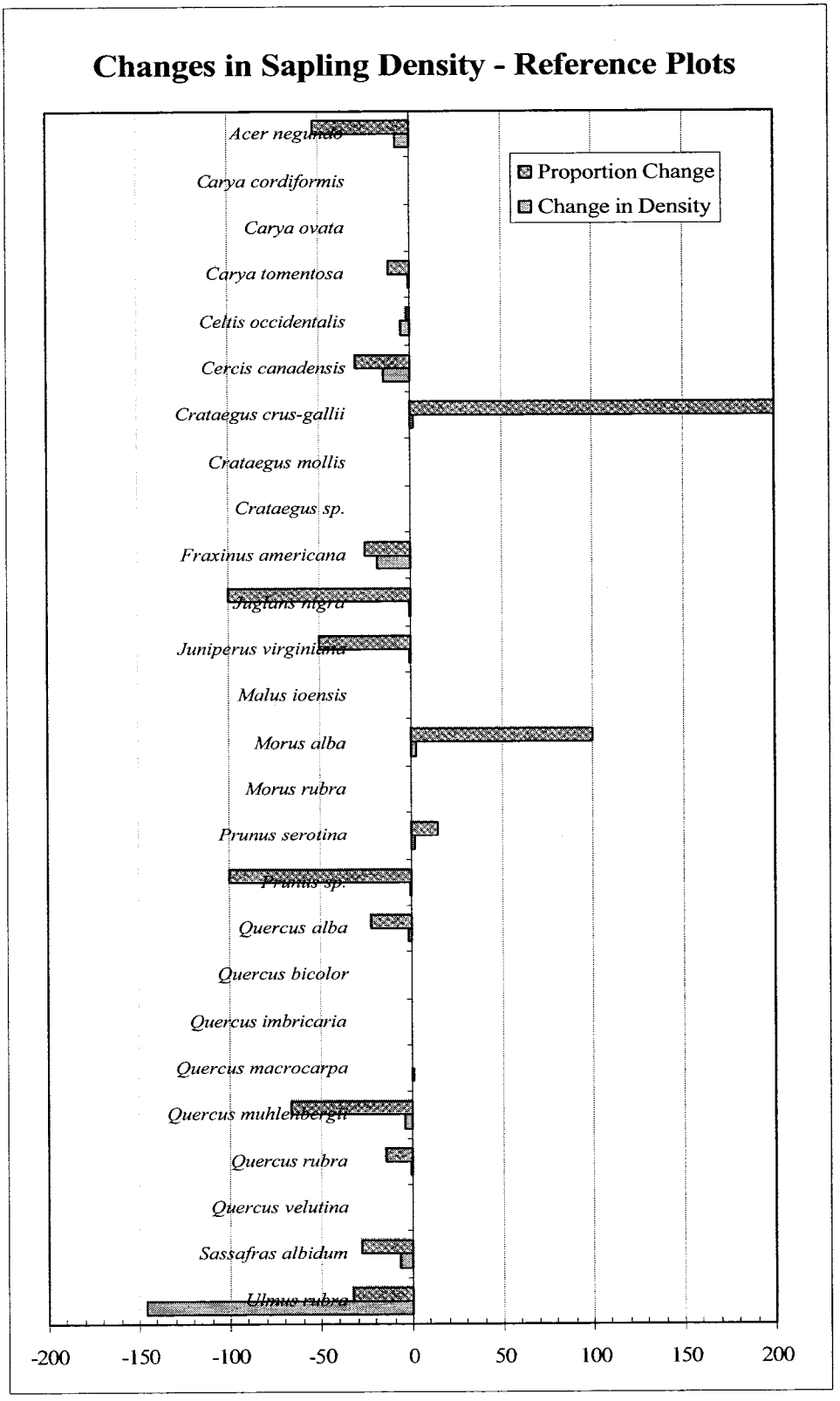
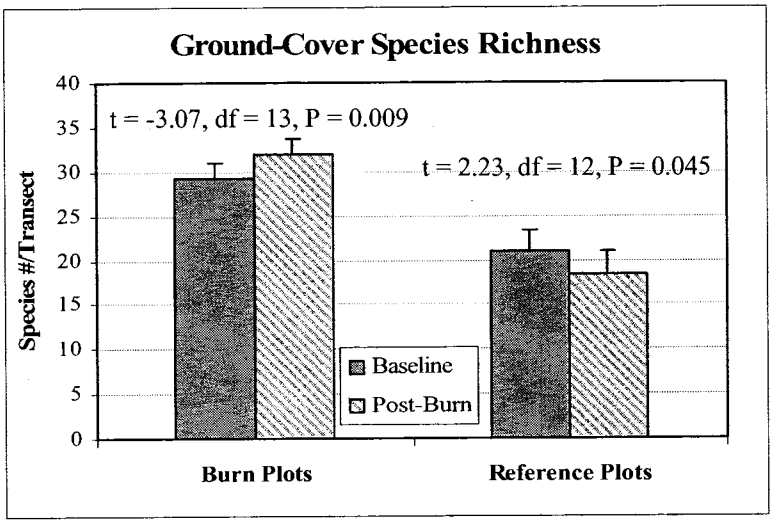
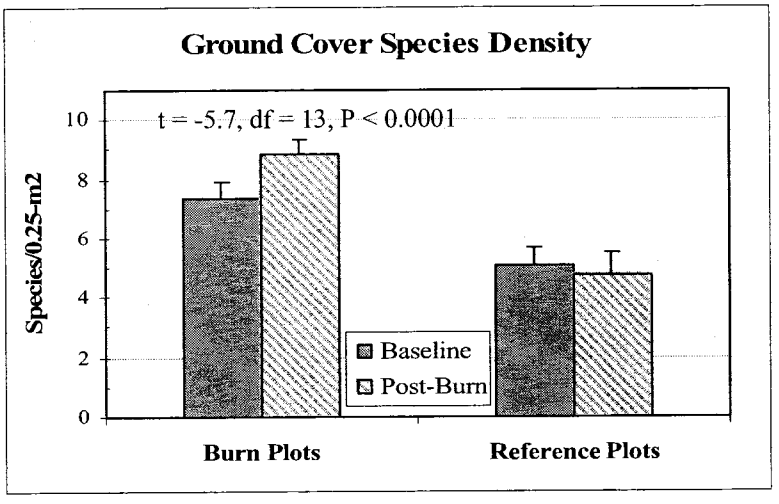


Figure 22. Changes in density and proportion of stems among sapling species in the fire-free reference plots at Beaver Dam State Park.





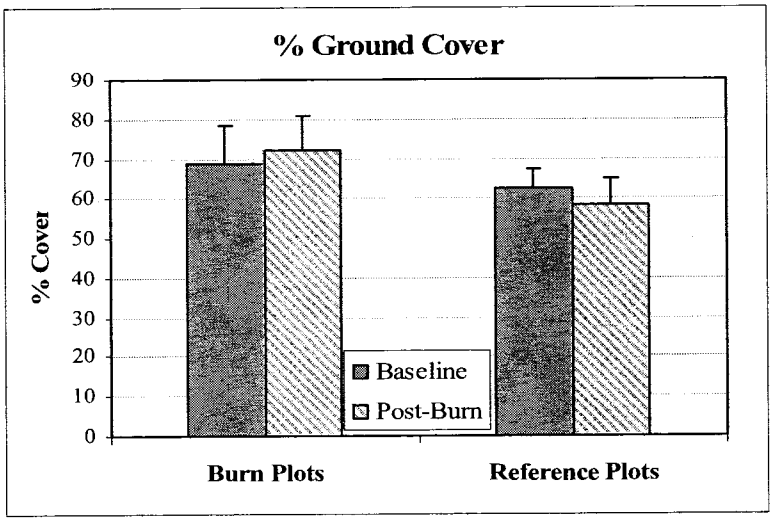


Figure 23. Changes in ground-cover species richness, species density, and % cover showing before-after differences in fire-treatment Burn Plots and fire-free Reference Plots, Beaver Dam State Park. Statistically significant differences are shown.

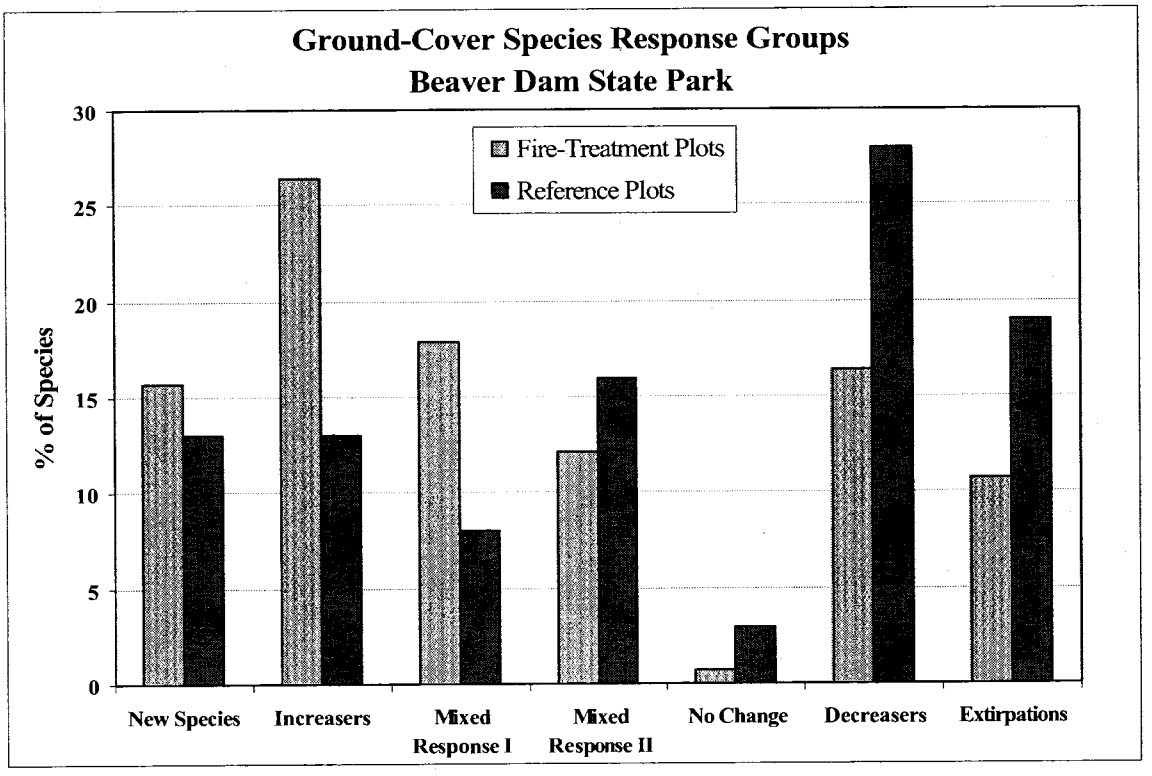
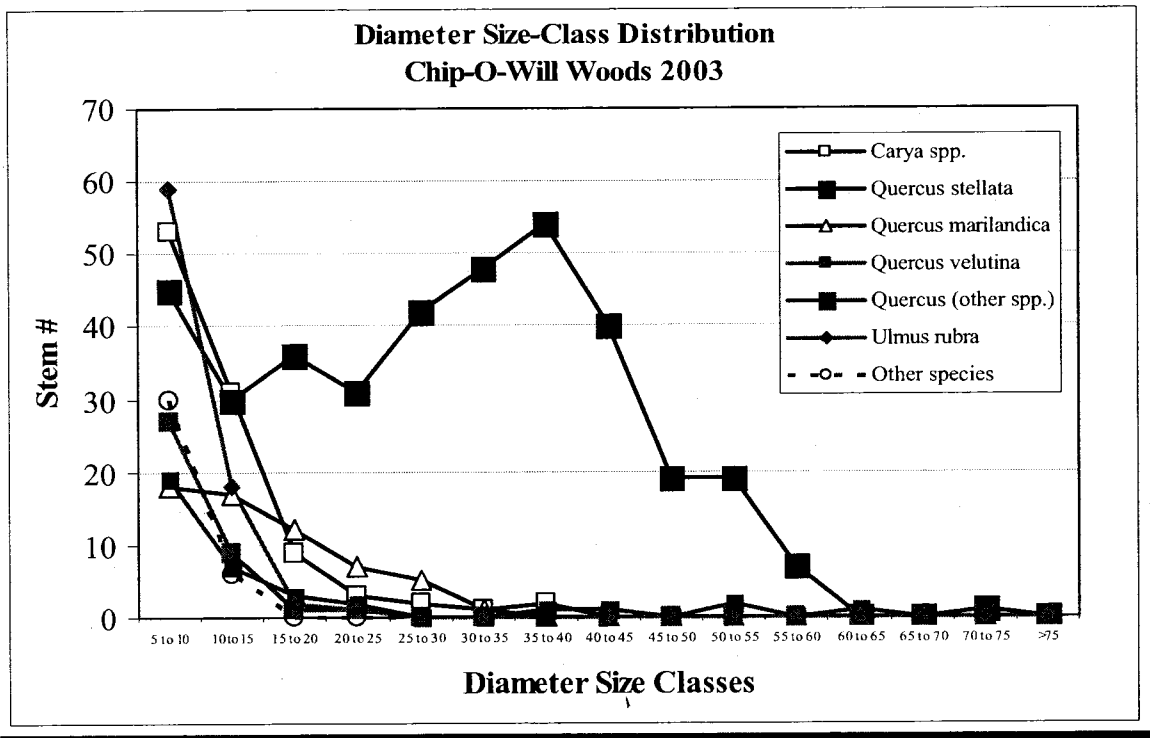


Figure 24. Response groupings for ground-cover species comparing fire-treatment and reference plots. New species are speices found in plots only after baseline samples; Increasers are speices that increased in both frequency and % cover; Mixed I species increased in frequency but declined in % cover; Mixed II species decreased in frequency and increased in % cover; Decreasers are species that declined in both frequency and % cover; Extirpations are species from baseline sample not found in post-treatment sample.



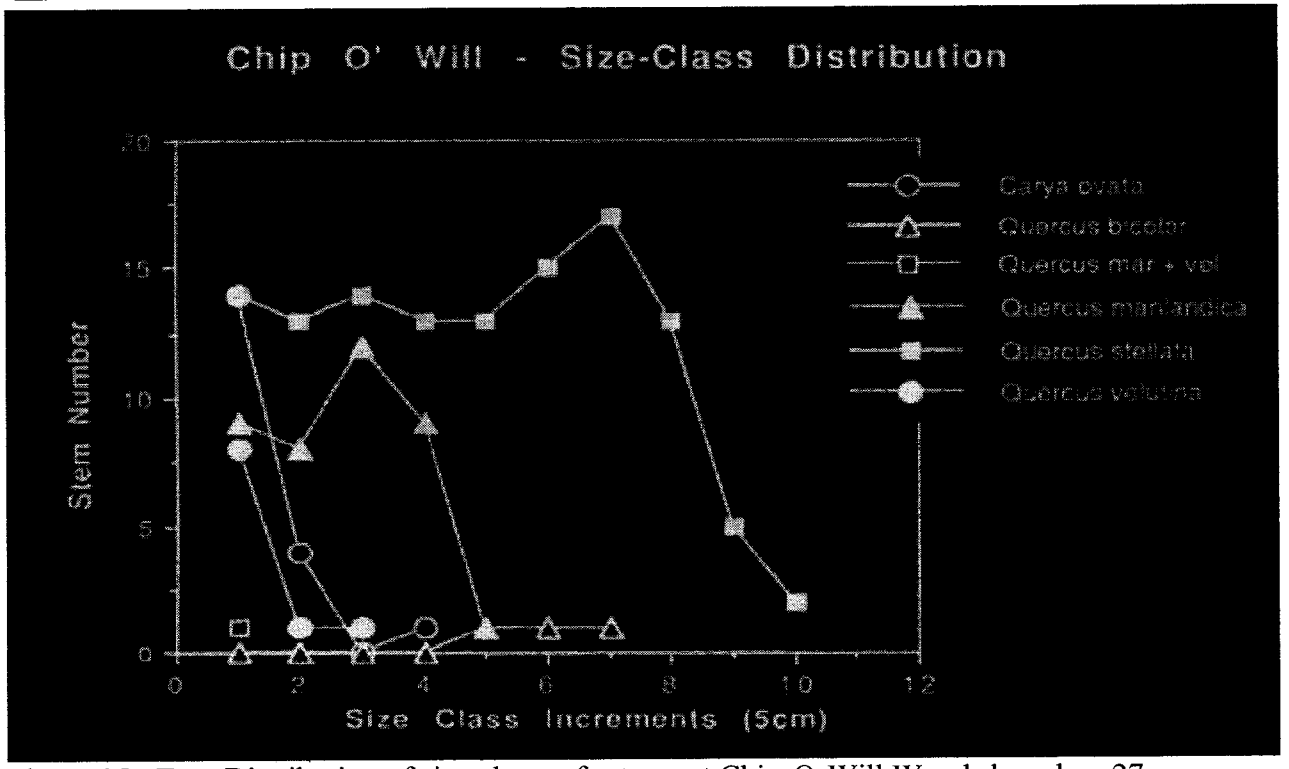


Figure 25. Top: Distribution of size classes for trees at Chip-O-Will Woods based on 27 baseline (2003) plots (0.05-ha) stratified throughout fire-treatment and reference units. Bottom: Size-class distribution of trees based on 8 plots (0.05-ha) sampled in 1989 from locations throughout Chip-O-Will Woods.

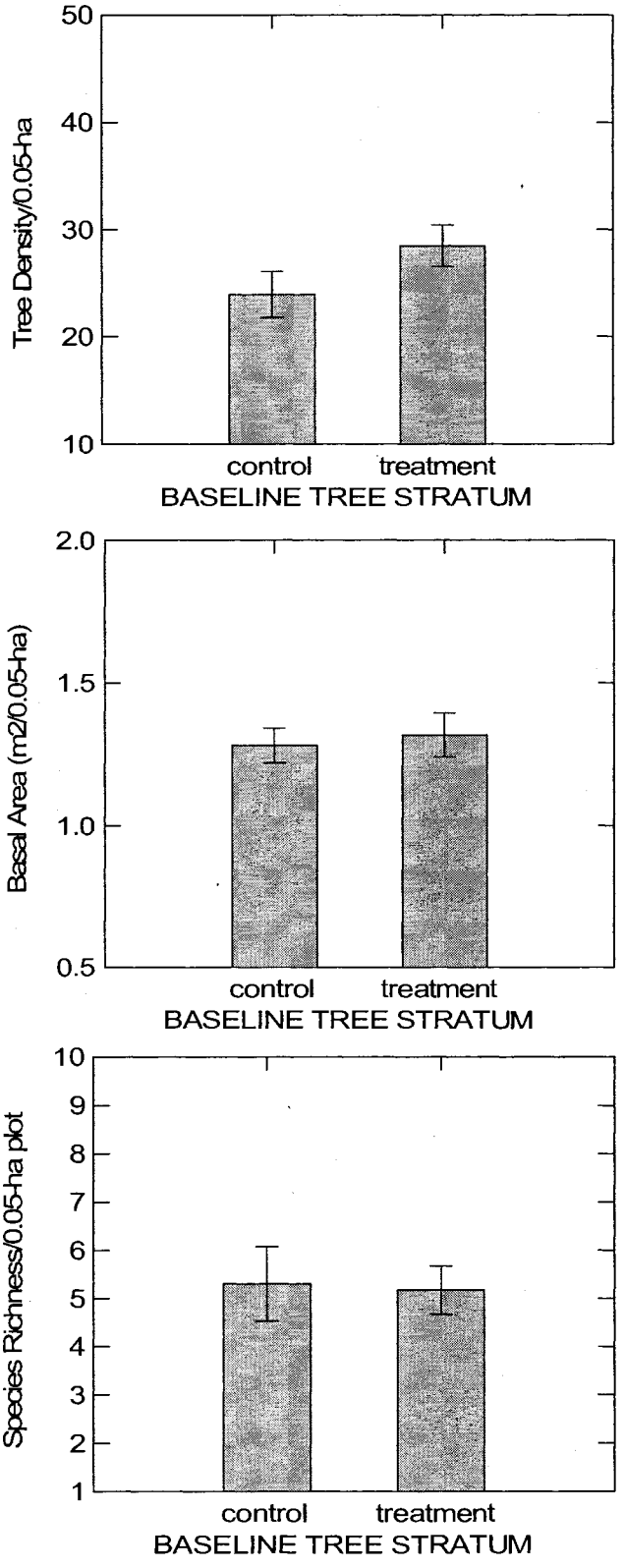


Figure 26. Baseline comparison of control and fire-treatment units at Chip-O-Will Woods.

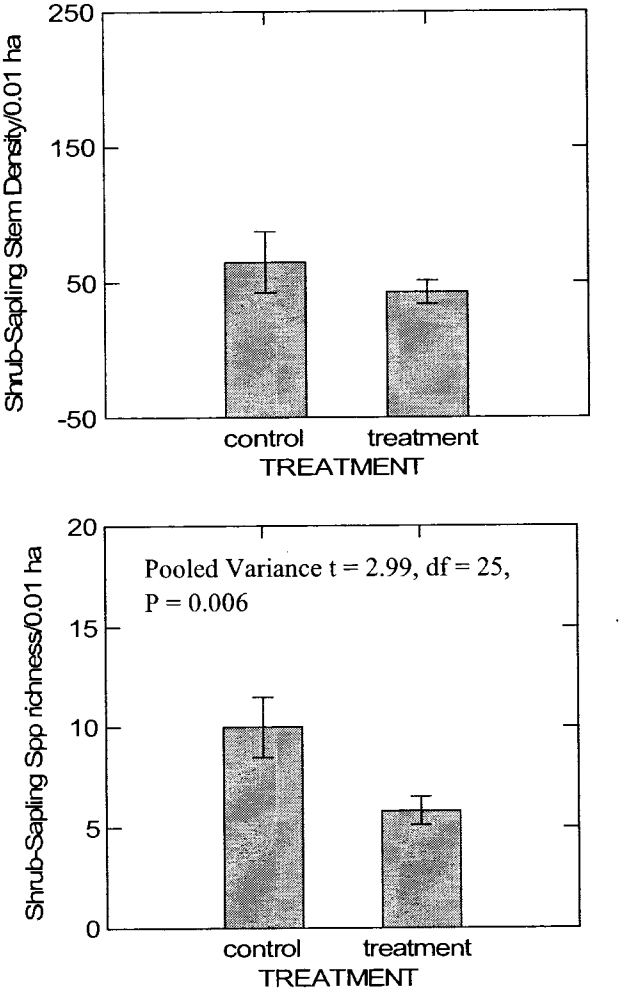


Figure 27. Baseline data from the shrub-sapling stratum comparing control and treatment plots. Chip-O-Will Woods, Washington County, Illinois.

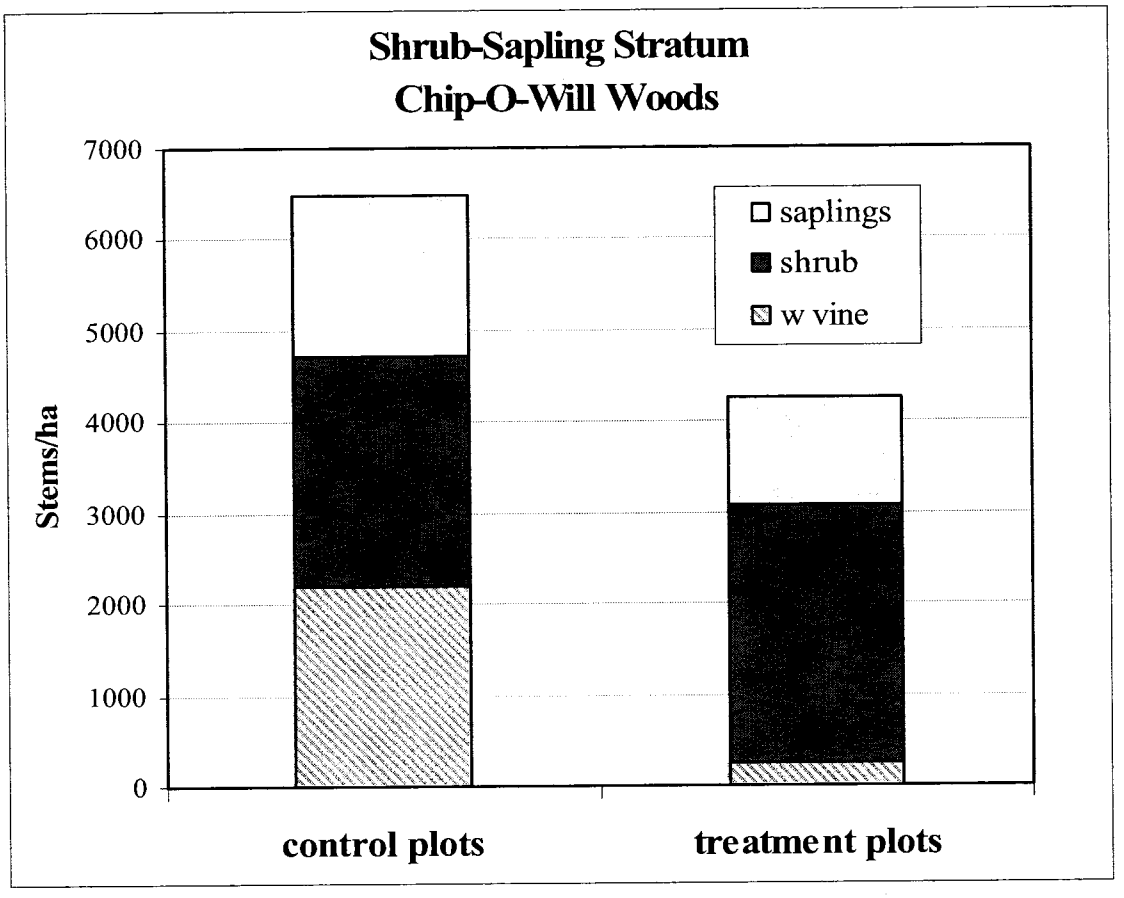


Figure 28. Relative composition of saplings, shrubs, and woody vines in the shrub-sapling stratum in fire-treatment and control plots.

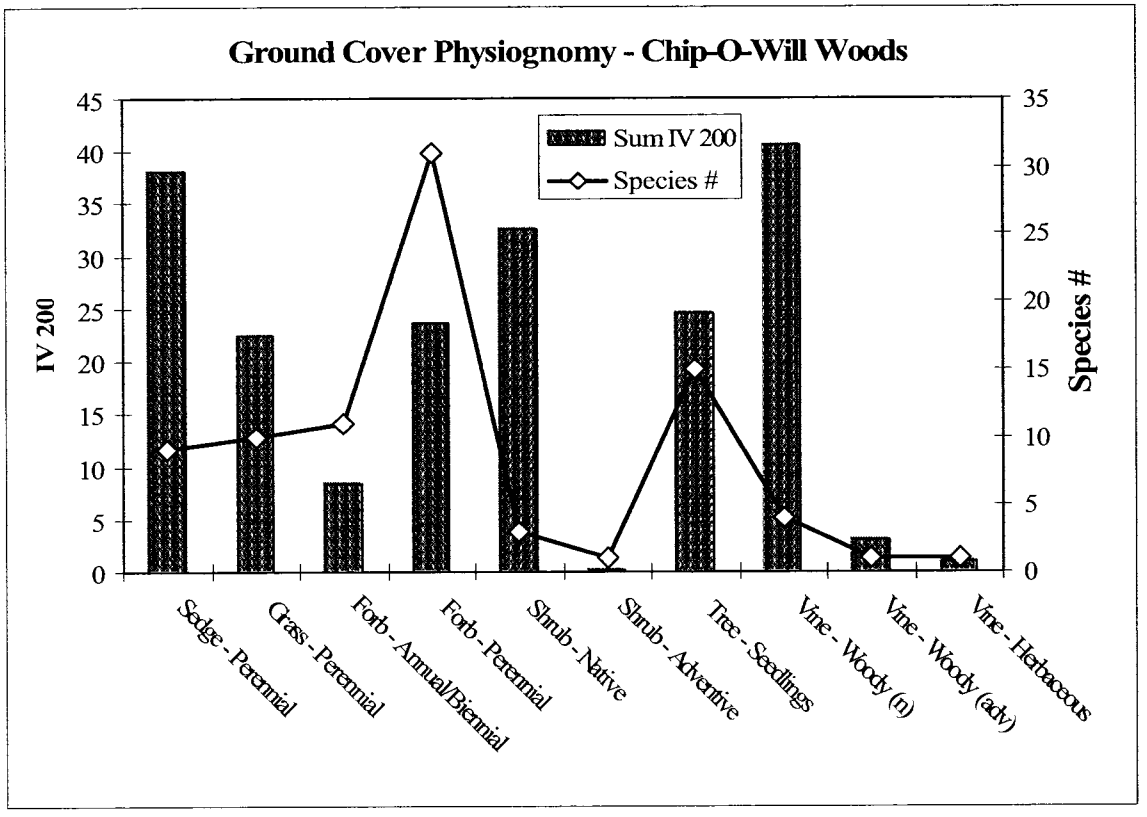


Figure 29. Distribution of physiognomic classes (sum importance value [IV 200]) in the ground-cover samples from combined fire-treatment and control plots at Chip-O-Will Woods. Total species number for each physiognomic class also is shown.

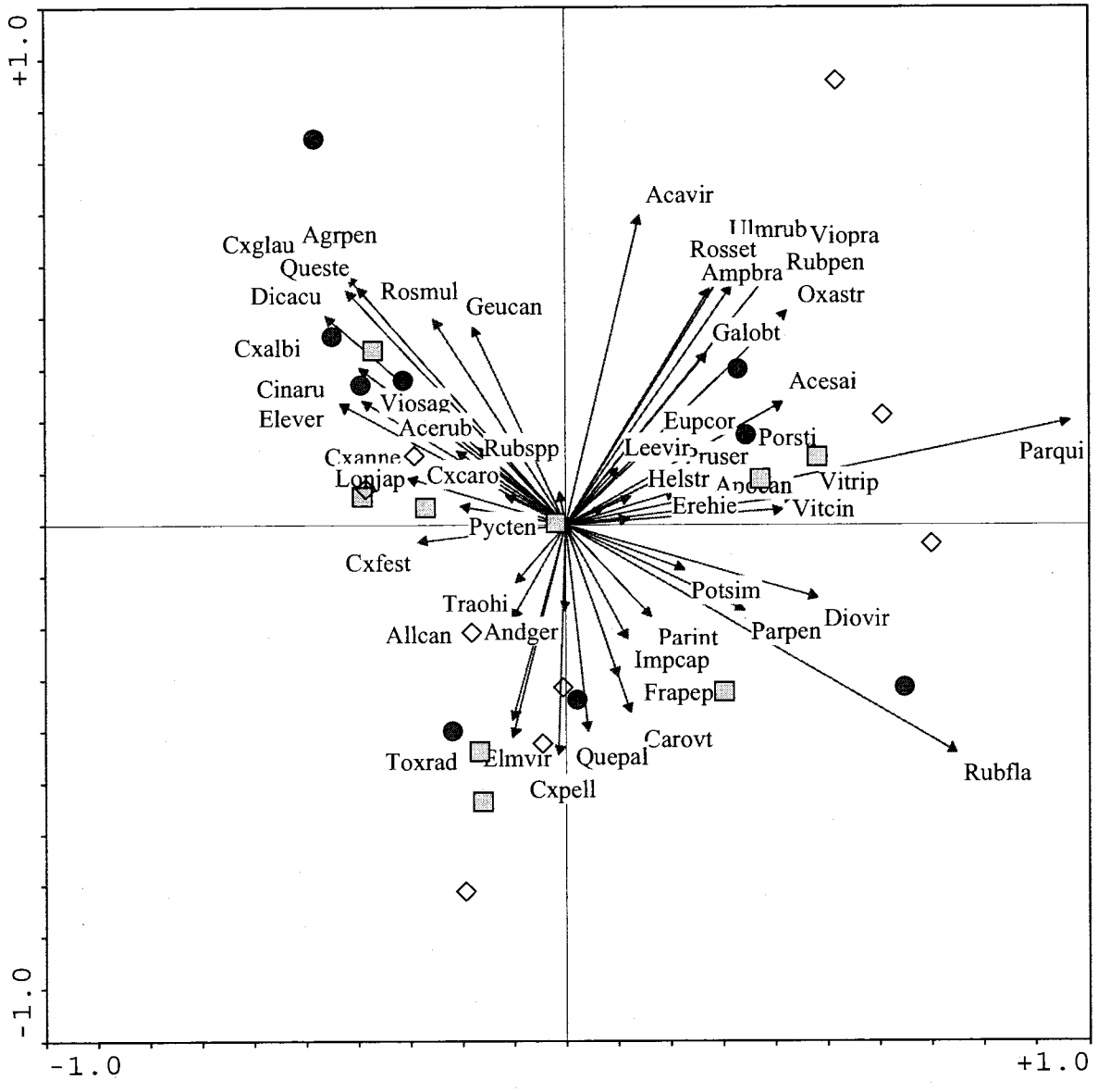


Figure 30. Principal Components Analysis (PCA) biplot of baseline (2003) ground-cover data from Chip-O-Will Woods in Washington County, Illinois. Data are based on occurrence number for the 50 top-ranking species. Solid symbols were fire-treatment plots and open symbols are fire-free reference plots. Round symbols represent plots from Unit B, square symbols are from Unit C, and diamonds are combined units D1 and D2. Species acronyms are listed below:

Acavir = *Acalypha virginica*
Acerub = *Acer rubrum*
Acesai = *Acer saccharinum*
Agrpen = *Agrostis perennans*
Allcan = *Allium canadense*
Ampbra = *Amphicarpa bracteata*
Andger = *Andropogon gerardii*
Apocan = *Apocynum cannabininum*
Carovt = *Carya ovata*
Cinaru = *Cinna arundinacea*
Cxalbi = *Carex albicans*
Cxanne = *Carex annectans*

Figure 30 caption continued.

Cxcaro = *Carex caroliniana*
Cxfest = *Carex festucacea*
Cxglau = *Carex glaucodea*
Cxpell = *Carex* cf. *pellita*
Dicacu = *Dichanthelium acuminatum*
Diovir = *Diospyros virginica*
Elever = *Eleocharis verrucosa*
Elmvir = *Elymus virginicus*
Erehie = *Erechtites hieracifolium*
Eupcor = *Eupatorium corollata*
Frapep = *Fraxinus pensylvanica* ssp. *subintegerrima*
Galobt = *Galium obtusum*
Geucan = *Geum canadense*
Helstr = *Helianthus strumosus*
Impcap = *Impatiens capensis*
Leevir = *Leersia virginica*
Lonjap = *Lonicera japonica*
Oxastr = *Oxalis stricta*
Parint = *Parthenium integrifolium*
Parpen = *Parietaria pensylvanica*
Parqui = *Parthenocissus quinquefolia*
Porsti = *Porteranthus stipulaceus*
Potsim = *Potentilla simplex*
Pruser = *Prunus serotina*
Pycten = *Pycnanthemum tenuifolium*
Quepal = *Quercus palustris*
Queste = *Quercus stellata*
Rosmul = *Rosa multiflora*
Rosset = *Rosa setigera*
Rubfla = *Rubus flagellaris*
Rubpen = *Rubus pensylvanica*
Rubspp = *Rubus* sp.
Toxrad = *Toxicodendron radicans*
Traohi = *Tradescantia ohiensis*
Ulmrub = *Ulmus rubra*
Viopra = *Viola pratincola*
Viosag = *Viola sagittata*
Vitcin = *Vitis cinerea*
Vitrip = *Vitis riparia.*

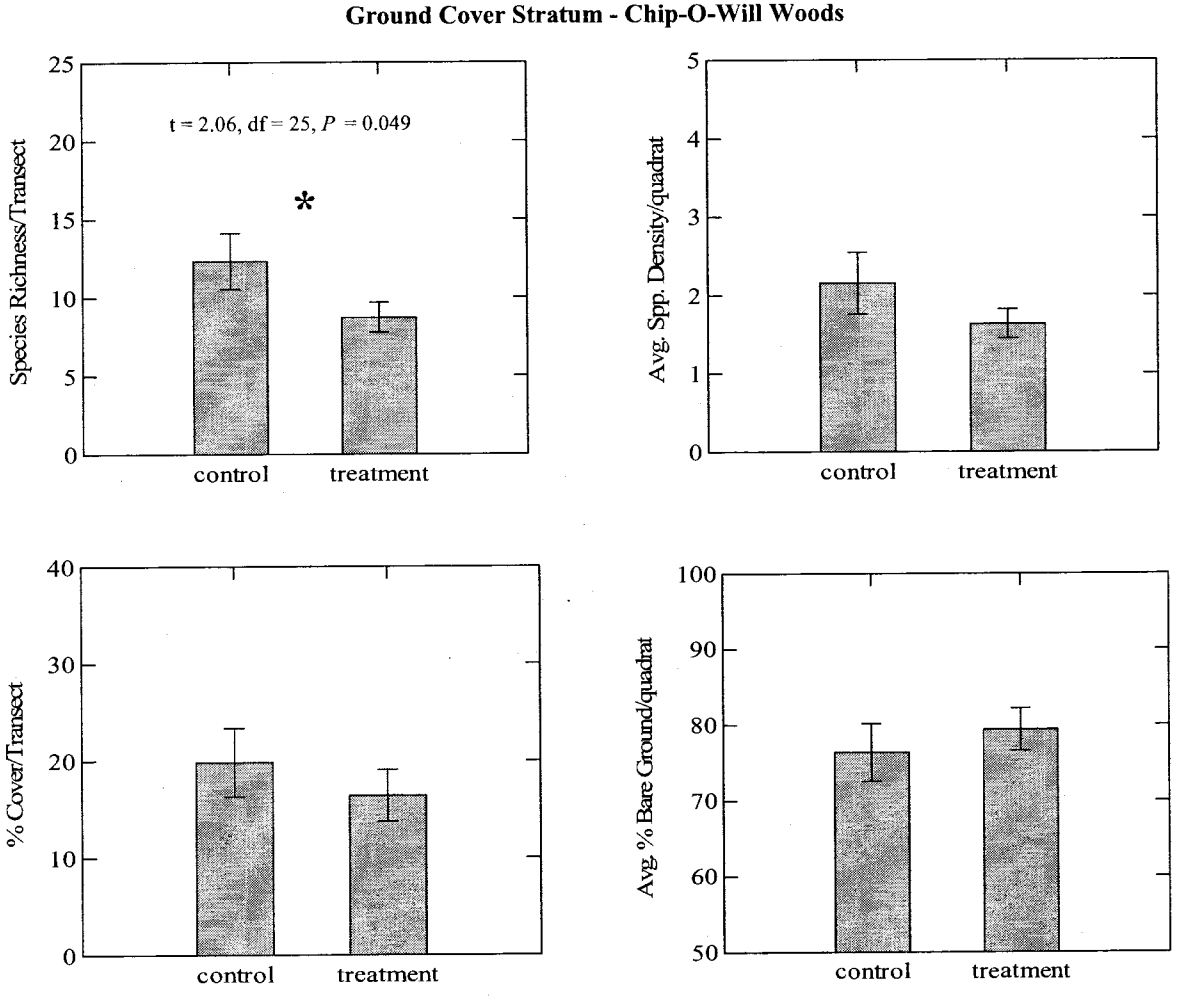


Figure 31. Baseline comparison of control and fire-treatment plots. Differences that were statistically significant (two-sample t-tests) are indicated with an asterisk (*).

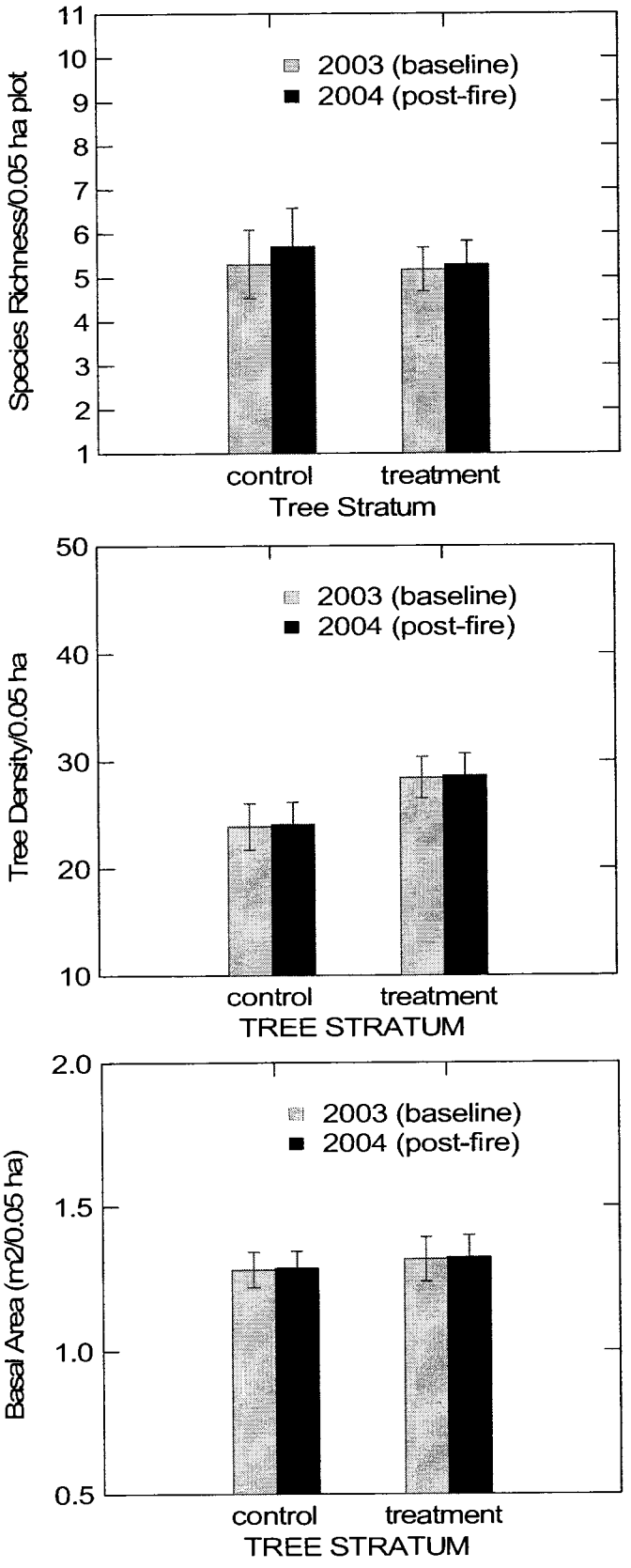


Figure 32. Changes in tree stratum at Chip-O-Will Woods in both fire-treatment and control plots.

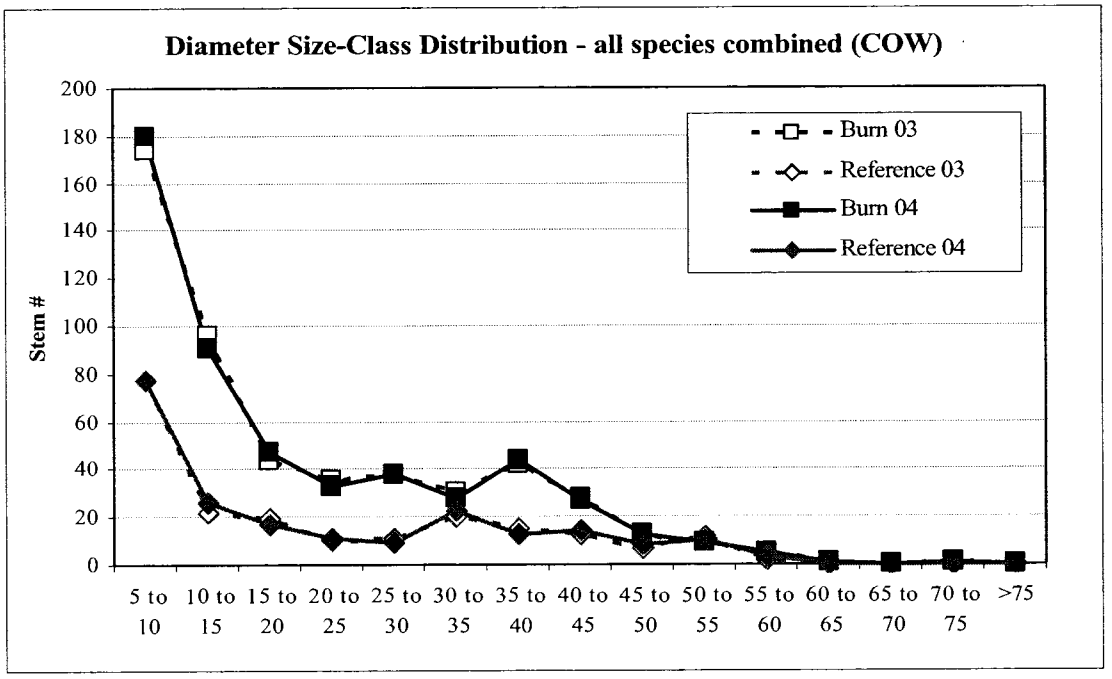


Figure 33. Distribution of size classes at Chip-O-Will Woods for all tree species combined in treatment and control units comparing baseline to post-treatment condition.

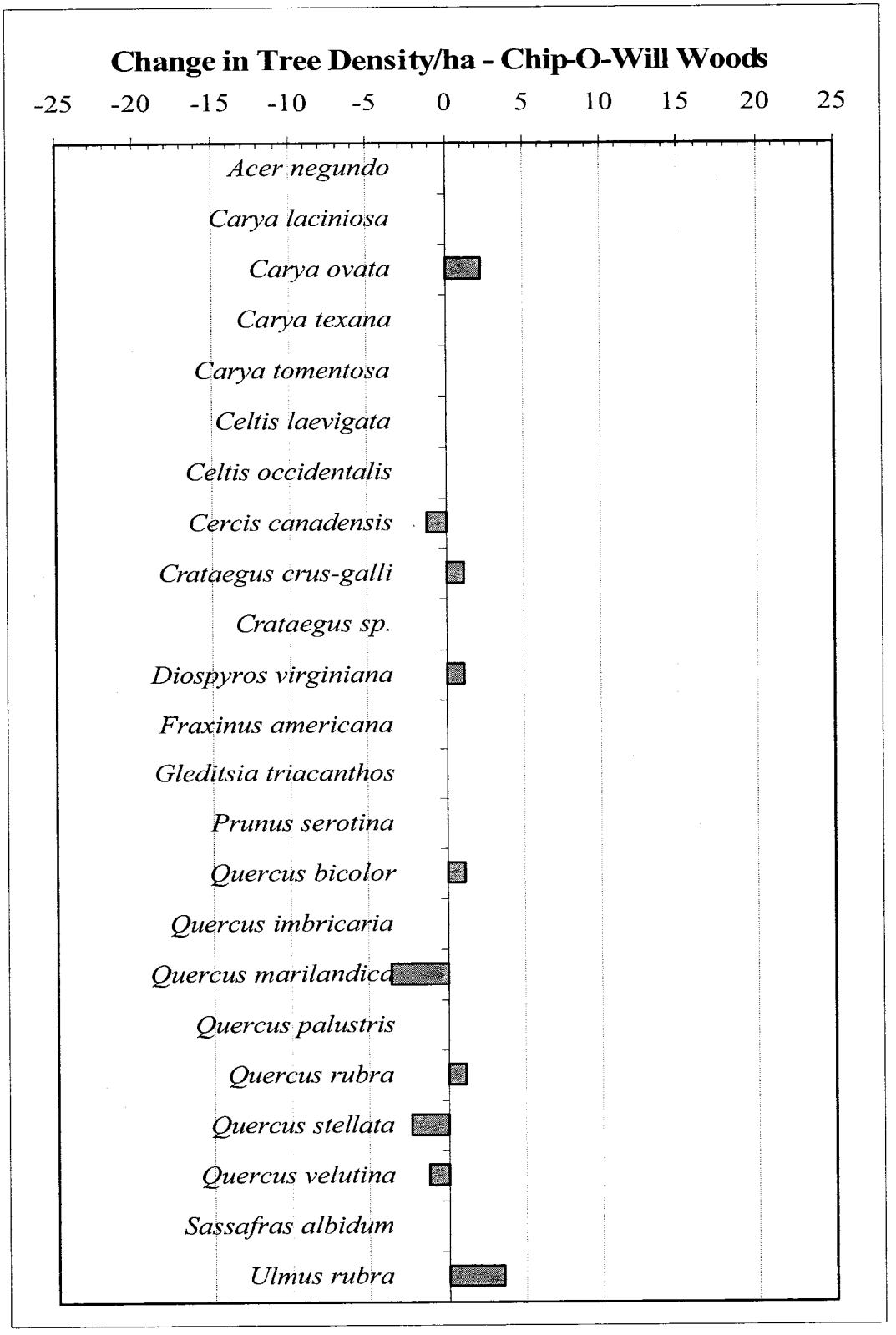
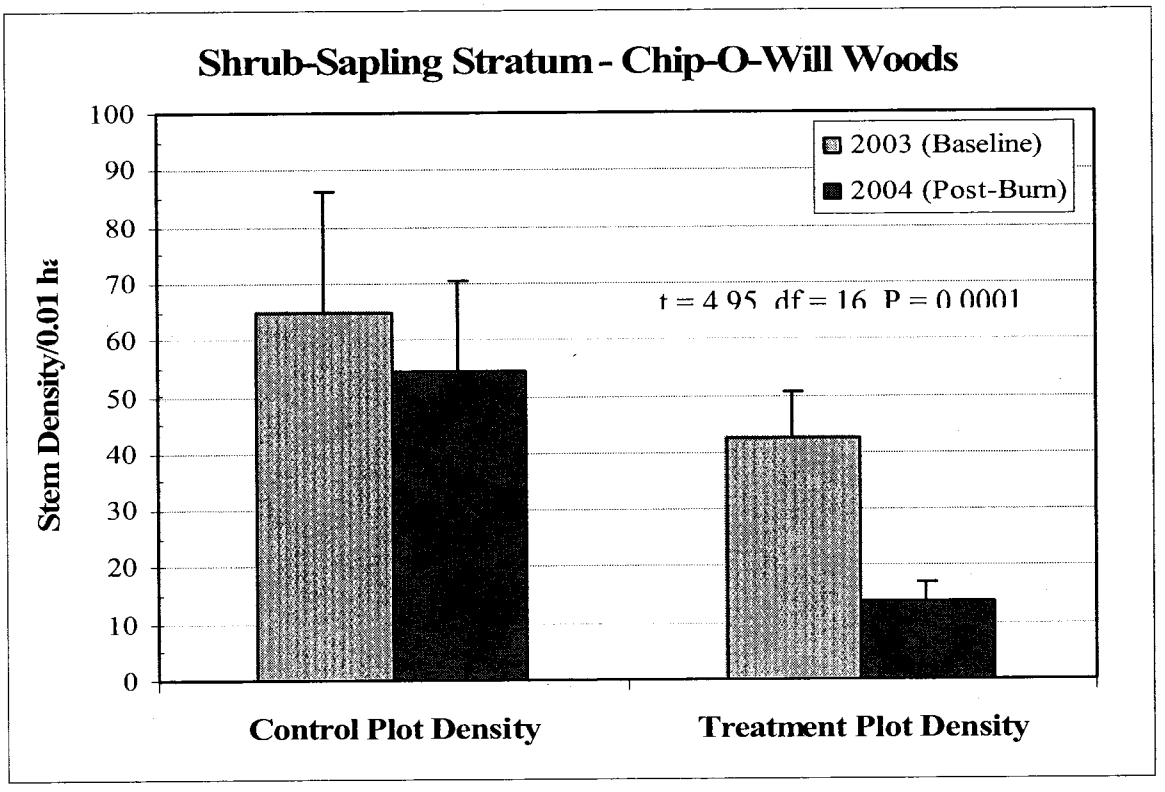


Figure 34. Changes in tree species density in the fire-treatment units at Chip-O-Will Woods following fire treatment.



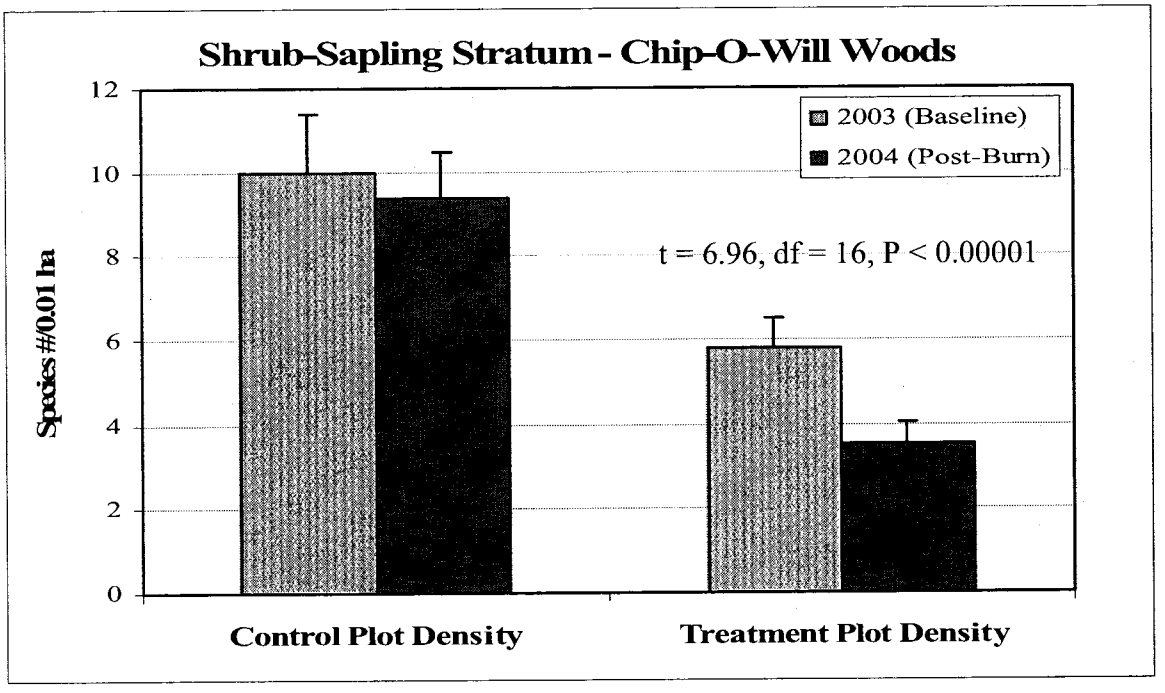


Figure 35. Before-after changes in density and species richness in shrub-sapling strata in fire-treatment and control plots at Chip-O-Will Woods. Significant differences are indicated.

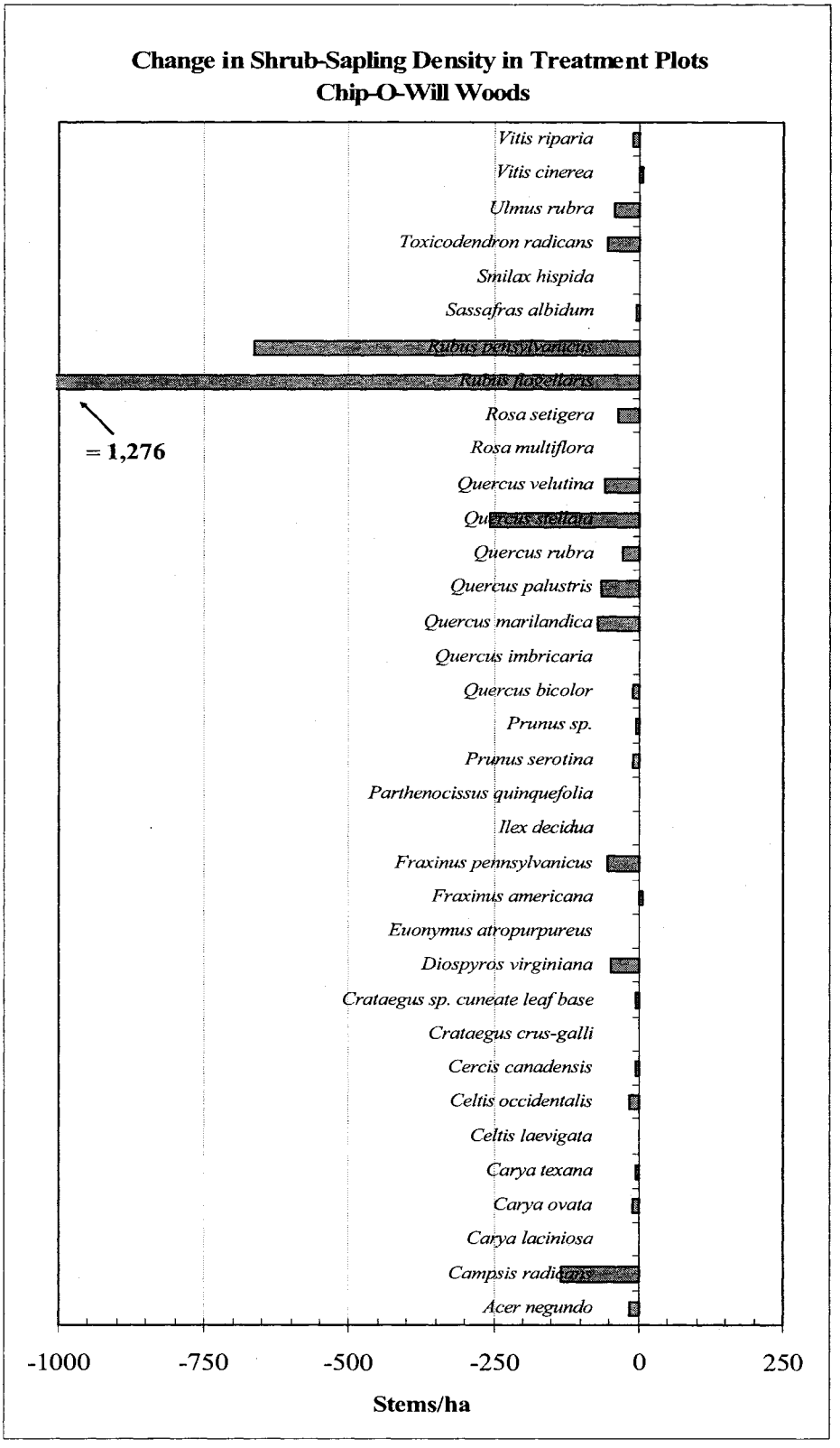


Figure 36. Changes in shrub-sapling species density in treatment plots following fire-treatment, Chip-O-Will Woods.

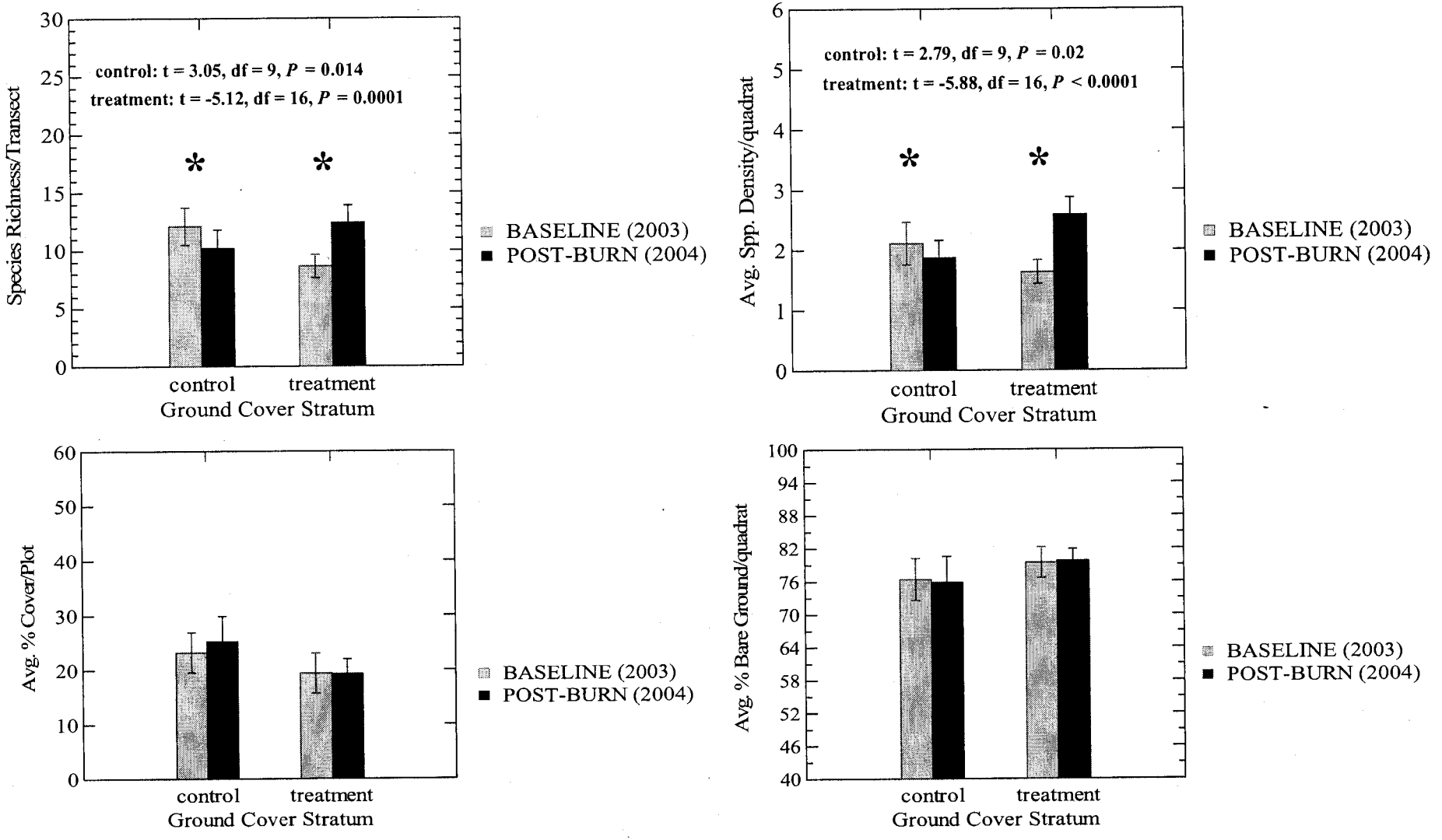


Figure 37. Baseline to post-treatment differences in fire-treatment and control ground-cover plots at Chip-O-Will Woods. Differences between baseline (2003) and post-treatment (2004) data that are statistically different (paired t-tests) are indicated by asterisks (*).

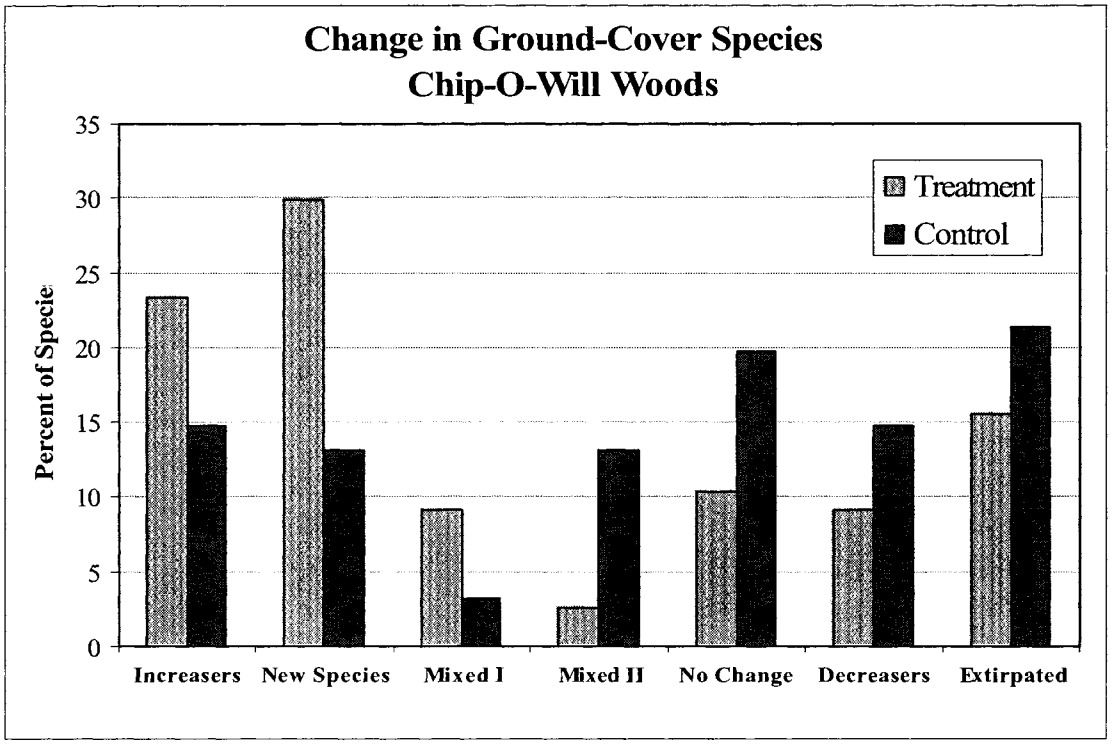


Figure 38. Response categories for treatment and control ground-cover plots at Chip-O-Will Woods comparing baseline (2003) and post-fire (2004) differences among species. Increasers and decreasers are species that changed in both occurrence number and % cover. Mixed I model includes species that increased in occurrences but declined in % cover. Mixed II model are species that declined in occurrences but increased in % cover. Extirpated species declined to zero.

Table 1. Global positioning coordinates for permanently marked plots. Coordinate represents a centroid marked by angle-iron post for a triad of nested tree plots. Tree plot centers are 50 m at 120 degree angles from the coordinates, starting at 0 degrees N.

Beaver Dam State Park Plot Coordinates

Plot	N Latitude		W Longitude	
1x12A	N	39.20714	W	89.97408
1x12B	N	39.20805	W	89.97422
1x15	N	39.21378	W	89.96971
1x5B	N	39.21271	W	89.98752
1x7	N	39.21480	W	89.97945
2x18A	N	39.21346	W	89.96184
4x5B	N	39.21351	W	89.98653
5x4	N	39.21235	W	89.99300
5x7	N	39.21353	W	89.97973

Chip-O-Will Woods Plot Coordinates

Plot	N Latitude		W Longitude	
Bx1A	N	38.45714	W	89.61056
Bx1B	N	38.45663	W	89.61124
Bx1C	N	38.45626	W	89.60957
Cx1B	N	38.45960	W	89.61131
Cx2B	N	38.45868	W	89.60832
Cx2C	N	38.45954	W	89.60942
D1x4A	N	38.46058	W	89.60976
D1x4B	N	38.46122	W	89.61066
D1x4C	N	38.46249	W	89.61205
D2x3	N	38.45848	W	89.60642

Table 2. Summary of burn dates, atmospheric conditions, and fire behavior at Beaver Dam State Park (BDSP and Chip-O-Will Woods (COW).

Site	Unit	Date	Temperature	Relative Humidity	Wind Speed (direction)	Burn Size (acres)	Relative Fire Intensity	% Coverage
BDSP	5	3-Dec-03	41 F	54%	< 5 mph (S)	45	Cool	50
	7	12-Mar-04	30 to 39 F	53%	5 mph (NW)	25	Cool	60
	15	16-Mar-05	45 F	35%	8 mph (W)	15	Moderate	90
	4	16-Mar-05	54 F	24%	5 to 10 mph (W)	42	Moderate	80
COW	B	24-Mar-04	70 F	40%	15 to 20 mph (S)	35	Cool	70
	C	24-Mar-04	73 F	38%	15 to 20 mph (S)	25	Cool	90

Table 3. Baseline tree density and basal area from combined fire-treatment and reference plots at Beaver Dam State Park. Trees are shown in decending rank order of importance value (IV 200 = rel. basal area + rel. density).

tree density	Density/ha	Basal Area m2/ha	IV 200
Ulmus rubra	242.96	2.7888	41.31
Celtis occidentalis	127.41	2.1148	24.19
Quercus alba	54.07	4.2356	23.19
Quercus velutina	28.15	4.2618	20.04
Carya ovata	68.15	2.0513	16.50
Quercus stellata	22.22	2.7774	13.55
Prunus serotina	41.48	0.9887	9.04
Cercis canadensis	48.89	0.4916	8.04
Quercus muhlenbergii	26.67	0.7816	6.38
Sassafras albidum	36.30	0.3028	5.73
Quercus macrocarpa	5.93	1.2391	5.54
Quercus rubra	14.81	0.9419	5.51
Gleditsia triacanthos	7.41	0.8163	4.09
Carya tomentosa	13.33	0.3722	3.12
Juglans nigra	8.15	0.4872	2.91
Quercus imbricaria	7.41	0.2940	2.07
Morus rubra	8.15	0.2020	1.81
Maclura pomifera	6.67	0.1686	1.49
Carya cordiformis	4.44	0.1293	1.06
Vitis sp.	7.41	0.0244	1.02
Fraxinus americana	3.70	0.0706	0.74
Morus alba	2.96	0.0636	0.62
Vitis riparia	4.44	0.0121	0.60
Liquidambar styraciflua	1.48	0.0915	0.54
Ulmus americana	0.74	0.0917	0.45
Carya ovalis	0.74	0.0184	0.16
Acer negundo	0.74	0.0040	0.11
Quercus bicolor	0.74	0.0029	0.10
Vitis cinerea	0.74	0.0019	0.10
SUMMARY	796.30	25.83	200.00

Table 4. Baseline summary data from shrub-sapling stratum combining data from all sample plots at Beaver Dam State Park. IV 200 = sum of relative density (RD) and relative frequency (RF).

	Density per ha	Frequency	IV200 (RD+RF)
Ulmus rubra	2,851.9	27	30.14
Rosa multiflora	1,877.8	22	21.34
Celtis occidentalis	1,385.2	26	19.19
Lonicera maackii	1,533.3	18	17.44
Ribes missouriense	1,337.0	8	12.48
Rubus pensylvanicus	729.6	14	10.22
Fraxinus americana	392.6	20	9.90
Staphylea trifolia	1,051.9	3	8.66
Sassafras albidum	640.7	10	8.16
Cercis canadensis	259.3	17	7.88
Symphoricarpos orbiculatus	629.6	7	7.02
Carya cordiformis	140.7	12	5.26
Prunus serotina	114.8	12	5.07
Carya ovata	107.4	10	4.31
Quercus muhlenbergii	96.3	8	3.52
Rhus aromatica	125.9	5	2.68
Carya tomentosa	44.4	6	2.44
Corylus americana	140.7	4	2.43
Quercus alba	37.0	6	2.39
Quercus rubra	33.3	6	2.36
Zanthoxylum americanum	70.4	4	1.92
Ptelea trifoliata	22.2	4	1.57
Acer negundo	55.6	3	1.46
Cornus racemosa	14.8	3	1.17
Rhus glabra	18.5	2	0.84
Rubus occidentalis	14.8	2	0.81
Cornus drummondii	11.1	2	0.79
Morus alba	11.1	2	0.79
Euonymus atropurpureus	7.4	2	0.76
Viburnum prunifolium	7.4	2	0.76
Juglans nigra	7.4	2	0.76
Prunus sp.	7.4	2	0.76
Lindera benzoin	14.8	1	0.46
Sambucus canadensis	7.4	1	0.41
Juniperus virginiana	7.4	1	0.41
Quercus velutina	7.4	1	0.41
Elaeagnus umbellata	3.7	1	0.38
Prunus americana	3.7	1	0.38
Crataegus crus-gallii	3.7	1	0.38
Crataegus mollis	3.7	1	0.38
Crataegus sp.	3.7	1	0.38
Malus ioensis	3.7	1	0.38
Morus rubra	3.7	1	0.38
Quercus imbricaria	3.7	1	0.38
DENSITY	13,844.4		200.00

Table 5. Summary data from shrub-sapling stratum at Beaver Dam State Park showing sum importance of *Quercus* and *Carya* species and importance of native and adventive (non-native) species.

Unit 4

	sum IV 200	% IV
Quercus spp	2.94	1.47
Carya spp	2.94	1.47
SUM	5.88	2.94
Native	197.06	98.53
Adventive	2.94	1.47
		100.00

Unit 5

	sum IV 200	% IV
Quercus spp	1.10	0.55
Carya spp	3.31	1.66
SUM	4.42	2.21
Native	169.64	84.82
Adventive	30.36	15.18
		100.00

Unit 7

	sum IV 200	% IV
Quercus spp	12.02	6.01
Carya spp	9.06	4.53
SUM	21.08	10.54
Native	129.23	64.61
Adventive	70.77	35.39
		100.00

Unit 12

	sum IV 200	% IV
Quercus spp	8.27	4.14
Carya spp	17.75	8.88
SUM	26.02	13.01
Native	169.10	84.55
Adventive	30.90	15.45
		100.00

Unit 15

	sum IV 200	% IV
Quercus spp	0.00	0.00
Carya spp	10.66	5.33
SUM	10.66	5.33
Native	176.92	88.46
Adventive	23.08	11.54
		100.00

Unit 18

	sum IV 200	% IV
Quercus spp	10.27	5.13
Carya spp	15.26	7.63
SUM	25.53	12.77
Native	182.79	91.40
Adventive	17.21	8.60
		100.00

Table 6. Baseline (2003) ground-cover species composition from all sample units at Beaver Dam State Park. Data are shown in descending rank order of importance value. IV 200 is sum of relative frequency and relative cover.

SPECIES	Occur-rences (324 quadrats)	% Freq-uency	Avg. % Cover	IV 200
Parthenocissus quinquefolia	224	69.14	13.5015	31.308
Sanicula odorata	177	54.63	12.8519	28.085
Ulmus rubra	115	35.49	4.8225	12.841
Eupatorium rugosum	144	44.44	3.3997	12.035
Circaea lutetiana	79	24.38	2.2515	7.195
Helianthus strumosus	28	8.64	3.0000	5.925
Impatiens capensis	48	14.81	2.0432	5.406
Geum canadense	75	23.15	0.5262	4.361
Viola sororia	62	19.14	0.4290	3.596
Polygonum virginicum	56	17.28	0.6003	3.574
Pilea pumila	53	16.36	0.3426	3.037
Celtis occidentalis	45	13.89	0.3133	2.613
Lonicera maackii	31	9.57	0.6636	2.486
Solidago ulmifolia	23	7.10	0.9074	2.481
Festuca obtusa	32	9.88	0.6204	2.467
Vitis riparia	45	13.89	0.1914	2.426
Phryma leptostachya	32	9.88	0.5401	2.344
Toxicodendron radicans	21	6.48	0.7654	2.168
Bromus pubescens	25	7.72	0.5988	2.102
Staphylea trifolia	13	4.01	0.8873	1.976
Galium circaezans	33	10.19	0.2269	1.912
Poa sylvestris	18	5.56	0.6019	1.775
Carex radiata	12	3.70	0.7870	1.775
Cercis canadensis	25	7.72	0.2716	1.601
Sanicula canadensis	9	2.78	0.7593	1.590
Smilacina racemosa	18	5.56	0.4630	1.563
Carex albicans	10	3.09	0.6914	1.533
Smilax hispida	23	7.10	0.2778	1.516
Carex hirtifolia	12	3.70	0.5787	1.456
Rubus pensylvanicus	17	5.25	0.4090	1.432
Carex cephalophora	17	5.25	0.3997	1.418
Carex blanda	18	5.56	0.3287	1.357
Elymus villosus	11	3.40	0.5370	1.344
Arisaema triphyllum	18	5.56	0.2932	1.302
Elymus hystrix	14	4.32	0.3935	1.267
Symphoricarpos orbiculatus	13	4.01	0.3441	1.144
Silene stellata	10	3.09	0.4090	1.101
Sassafras albicans	12	3.70	0.2747	0.990
Muhlenbergia sobolifera	7	2.16	0.4290	0.989
Botrychium virginicum	18	5.56	0.0741	0.967

Table 6 continued.

SPECIES	Occur-rences (324 quadrats)	% Freq-uency	Avg. % Cover	IV 200
Galium triflorum	12	3.70	0.2454	0.945
Agrimonia rostellata	13	4.01	0.2083	0.935
Rosa multiflora	10	3.09	0.2623	0.876
Cystopteris protrusa	14	4.32	0.1142	0.839
Cryptotaenia canadensis	15	4.63	0.0772	0.829
Cinna arundinacea	10	3.09	0.2253	0.819
Carex grisea	9	2.78	0.2562	0.819
Ribes missouriense	9	2.78	0.2315	0.781
Celastris scandens	8	2.47	0.2222	0.720
Elymus virginicus	7	2.16	0.2454	0.708
Chenopodium standleyanum	9	2.78	0.1790	0.701
Podophyllum peltatum	5	1.54	0.3009	0.698
Hackelia virginica	13	4.01	0.0509	0.694
Carex laxiflora	8	2.47	0.1852	0.663
Galium concinnum	10	3.09	0.1219	0.661
Phytolacca americana	9	2.78	0.1343	0.632
Prunus serotina	10	3.09	0.0756	0.590
Parietaria pensylvanica	11	3.40	0.0401	0.583
Campanula americana	4	1.23	0.2546	0.580
Bidens frondosa	10	3.09	0.0617	0.569
Amphicarpa bracteata	7	2.16	0.1481	0.559
Acalypha rhomboidea	10	3.09	0.0540	0.557
Cornus racemosa	6	1.85	0.1667	0.540
Agrimonia pubescens	7	2.16	0.1312	0.533
Specularia perfoliata	8	2.47	0.0880	0.514
Carya ovata	7	2.16	0.1157	0.509
Euonymus atropurpureus	6	1.85	0.1219	0.471
Polygonatum commutatum	7	2.16	0.0864	0.464
Carex sp. (seedling)	7	2.16	0.0787	0.452
Leersia virginica	5	1.54	0.1373	0.447
Rubus allegheninsis	6	1.85	0.0988	0.436
Dioscorea villosa	6	1.85	0.0849	0.414
Smilax lasioneuron	5	1.54	0.1127	0.410
Eupatorium purpureum	3	0.93	0.1713	0.405
Menispermum canadense	6	1.85	0.0694	0.391
Rhus aromatica	4	1.23	0.1111	0.360
Aster ontarionis	5	1.54	0.0756	0.353
Fraxinus americana	4	1.23	0.1034	0.348
Eupatorium serotinum	5	1.54	0.0679	0.341
Aristolochia serpentaria	6	1.85	0.0324	0.334
Viola pratincola	6	1.85	0.0247	0.322
Desmodium glutinosum	5	1.54	0.0525	0.317
Carex sp. (glabrous, lvs 3 mm)	5	1.54	0.0463	0.308
Aster lateriflorus	4	1.23	0.0741	0.303
dicot 3 seedling	6	1.85	0.0093	0.299
Carex oligocarpa	3	0.93	0.1019	0.298

Table 6 continued.

SPECIES	Occur-rences (324 quadrats)	% Freq-uency	Avg. % Cover	IV 200
Carya cordiformis	3	0.93	0.1019	0.298
Quercus rubra	5	1.54	0.0386	0.296
Calystegia sepium	4	1.23	0.0664	0.291
Rubus flagellaris	4	1.23	0.0664	0.291
Quercus velutina	5	1.54	0.0309	0.284
Viola triloba	5	1.54	0.0309	0.284
Acalypha virginica	5	1.54	0.0154	0.261
Scutellaria incana	2	0.62	0.0926	0.237
Vitis cinerea	2	0.62	0.0926	0.237
Teucrium canadense	3	0.93	0.0571	0.230
Trillium recurvatum	3	0.93	0.0571	0.230
Zanthoxylem americanum	3	0.93	0.0571	0.230
Phlox divaricata	4	1.23	0.0139	0.211
Quercus alba	3	0.93	0.0278	0.185
Campsis radicans	2	0.62	0.0556	0.180
Monarda bradburiana	2	0.62	0.0556	0.180
Asplenium platyneuron	3	0.93	0.0201	0.173
Diospyros virginiana	3	0.93	0.0201	0.173
Penstemon calycosa	3	0.93	0.0201	0.173
Erigeron annuus	3	0.93	0.0123	0.161
Osmorhiza longistylis	3	0.93	0.0123	0.161
Oxalis dillenii/stricta	3	0.93	0.0123	0.161
Quercus imbricaria	3	0.93	0.0123	0.161
Conyza canadensis	3	0.93	0.0046	0.149
Agastache nepetoides	2	0.62	0.0185	0.123
Dichanthelium boscii	2	0.62	0.0185	0.123
Geranium maculatum	2	0.62	0.0185	0.123
Carex hirsutella	1	0.31	0.0463	0.118
Carex jamesii	1	0.31	0.0463	0.118
Cornus drummondii	1	0.31	0.0463	0.118
Corylus americana	1	0.31	0.0463	0.118
Hydrophyllum virginianum	1	0.31	0.0463	0.118
Prenanthes sp.	1	0.31	0.0463	0.118
Ptelea trifoliata	1	0.31	0.0463	0.118
Quercus muhlenbergii	1	0.31	0.0463	0.118
Veronicastrum virginicum	1	0.31	0.0463	0.118
Woodsia obtusa	1	0.31	0.0463	0.118
Dichanthelium clandestinum	2	0.62	0.0108	0.111
Solidago canadensis	2	0.62	0.0108	0.111
Vernonia sp.	2	0.62	0.0108	0.111
Verbesina helianthoides	2	0.62	0.0108	0.111
Botrychium dissectum var. *obliqu*	2	0.62	0.0031	0.100
Dichanthelium acuminatum	2	0.62	0.0031	0.100
Oxalis fontana	2	0.62	0.0031	0.100
Blephelia ciliata	1	0.31	0.0093	0.062
Ipomoea sp.	1	0.31	0.0093	0.062

Table 6 continued.

SPECIES	Occur-rences (324 quadrats)	% Freq-uency	Avg. % Cover	IV 200
Morus alba	1	0.31	0.0093	0.062
Allium canadense	1	0.31	0.0015	0.050
Aplectrum hyemale	1	0.31	0.0015	0.050
Cacalia atriplicifolia	1	0.31	0.0015	0.050
Cardamine parviflora	1	0.31	0.0015	0.050
Dichanthelium villosissimum	1	0.31	0.0015	0.050
Galium aparine	1	0.31	0.0015	0.050
Lactuca biennis	1	0.31	0.0015	0.050
Lespedeza sp.	1	0.31	0.0015	0.050
Muhlenbergia schreberi	1	0.31	0.0015	0.050
Polygonum sp.	1	0.31	0.0015	0.050
SUM TOTALS	2110		65.2500	200.000
Total Species Richness	143			
Mean Richness/Transect	25.96			
Mean Species Density	6.51			

Table 7. Summary data for all vegetation strata, sample units, and years sampled at Beaver Dam State Park

		CANOPY STRATUM				SHRUB-SAPLING STRATUM			GROUND-COVER STRATUM		
UNIT	YEAR	Basal Area (m2/ha)	Denstiy/ha	Total Species Richness	Mean Species Richness	Stem Denstiy/ha	Total Species Richness	Mean Species Richness	Total Species Richness	Species Density	Perent Cover
Unit 4	2003	28.01	660	14	8.3	10,833	16	6.3	73	11.3	117.1
	2004	28.11	640	14	8.3	11,100	14	6.0	61	9.1	121.8
	2005	28.09	580	13	7.7	8,100	16	5.2	64	10.8	115.4
Unit 5	2003	25.99	803	13	7.7	9,850	33	8.9	82	7.7	75.9
	2004	26.17	797	15	8.3	9,383	26	7.0	75	8.1	78.1
Unit 7	2003	23.79	923	24	10.3	21,233	31	9.3	78	6.7	43.4
	2004	23.86	857	22	9.3	16,083	25	6.1	86	7.9	47.0
Unit 15	2003	22.86	880	17	10.3	8,000	16	8.2	39	5.4	52.1
	2005	22.97	833	14	8.7	3,067	15	5.2	43	6.8	59.9
Unit 12	2003	28.19	703	19	8.0	10,650	26	8.5	51	4.4	66.6
	2004	28.31	727	19	8.2	9,450	26	8.0	51	4.1	67.6
	2005	28.81	753	19	8.2	9,717	26	7.9	46	4.8	69.6
Unit 18	2003	25.80	773	18	11.0	25,467	24	11.0	39	4.4	46.4
	2004	26.42	853	18	11.3	25,000	26	11.2	28	3.2	36.4
	2005	27.13	860	19	11.3	20,100	20	9.8	29	2.7	25.1

Table 8. Ground-Cover response types in fire-treatment plots at Beaver Dam State Park . Total sample size is 168 quadrats.

A. INCREASERS - Species that increased in cover and frequency (37 spp)

SPECIES	Change in Occur. #	% frequency change	Change in % Cover	% change
Acalypha virginica	11	275.00	2.50	1,500.00
Allium canadense	4	400.00	0.79	1,900.00
Aster lateriflorus	2	100.00	2.29	152.78
Blephelia cf. *hirsuta*	1	100.00	1.04	416.67
Carex oligocarpa	4	133.33	2.00	72.73
Carya cordiformis	3	150.00	1.75	70.00
Circaea lutetiana	7	13.73	31.17	75.03
Cryptotaenia canadensis	2	16.67	1.50	85.71
Cystopteris protrusa	5	55.56	2.25	110.20
Dichanthelium clandestinum	2	100.00	0.08	28.57
dicot seedling (unknown)	7	700.00	0.71	1,700.00
Dioscorea villosa	1	20.00	1.67	200.00
Diospyros virginiana	1	100.00	0.25	100.00
Elymus hystrix	5	45.45	3.83	69.17
Eupatorium purpureum	1	50.00	1.25	39.47
Eupatorium rugosum	44	57.14	11.08	18.99
Festuca obtusa	2	10.53	0.17	2.34
Galium circaezans	9	39.13	0.79	9.55
Geum canadense	6	13.64	1.63	16.18
Hackelia virginica	25	625.00	4.54	778.57
Menispermum canadense	1	20.00	2.88	460.00
Muhlenbergia sobolifera	8	160.00	2.58	21.38
Osmorhiza longistylis	4	400.00	3.00	7,200.00
Parietaria pensylvanica	5	45.45	3.46	395.24
Phryma leptostachya	9	60.00	6.04	105.84
Pilea pumila	3	13.04	4.63	191.38
Polygonatum commutatum	1	33.33	1.25	71.43
Polygonum cristatum	4	133.33	1.83	104.76
Prunus serotina	21	525.00	2.96	507.14
Quercus alba	2	66.67	0.50	28.57
Rosa multiflora	2	40.00	3.38	79.41
Rubus pensylvanicus	2	13.33	8.38	71.28
Sanicula odorata	6	5.83	55.29	36.06
Smilacina racemosa	4	28.57	1.67	15.87
Symphoricarpos orbiculatus	2	22.22	8.67	187.39
Viola sororia	7	24.14	1.13	34.18
Vitis cinerea	1	100.00	0.25	20.00

Table 8 continued.

B. NEW SPECIES - Species that emerged during the study but were absent at baseline (22 Spp.)

SPECIES	Occur. #	Summed % Cover
Acalypha rhomboidea	20	2.08
Acer saccharinum	1	0.25
Arisaema dracontium	2	0.50
Aster pilosus	1	0.04
Calystegia sepium	1	0.04
Chenopodium standleyanum	10	4.88
Conyza canadensis	11	0.67
Cornus drummondii	1	1.25
dicot 2 (cf. *Lobelia inflata*) seedling	2	0.08
Erechtites hieracifolia	1	0.04
Festuca pratensis	1	0.25
Gleditsia triacanthos	2	0.29
Juniperus virginiana	3	0.13
Lactuca biennis	1	0.25
Lactuca canadensis	3	0.13
Physalis sp.	1	0.25
Poaceae (cf. Agrostis sp.)	2	0.08
Quercus rubra	1	0.25
Ranunculus abortivus	1	0.04
Ranunculus septentrionalis	1	0.25
Specularia perfoliata	4	0.17
Viola pensylvanica pubescens	1	0.04

C. MIXED I - Species that increased or remained same in frequency but decreased in % cover (25 Spp.);

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Agrimonia pubescens/A. rostellata	4	40.00	-2.42	-33.14
Arisaema triphyllum	1	10.00	-1.21	-21.80
Bromus pubescens	8	32.00	-5.88	-25.68
Carex albicans	3	33.33	-4.75	-23.70
Carex blanda	7	26.92	-5.63	-24.86
Carex cf. grisea	4	66.67	-2.29	-44.35
Carex hirtifolia	1	20.00	-1.04	-20.33
Carex radiata	0	0.00	-2.88	-38.98
Celtis occidentalis	4	15.38	-0.83	-11.24
Elymus villosus	1	20.00	-5.38	-54.43
Oxalis dillenii/stricta	5	250.00	0.00	0.00
Phlox divaricata	0	0.00	-0.21	-27.78
Phytolacca americana	3	300.00	-0.88	-70.00
Poa sylvestris	3	50.00	-3.21	-44.25
Quercus imbricaria	0	0.00	-0.08	-28.57
Quercus muhlenbergii	0	0.00	-1.00	-80.00
Scutellaria incana	0	0.00	-1.00	-66.67

Table 8 continued.

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Smilax hispida	0	0.00	-1.58	-36.19
Smilax lasioneuron	0	0.00	-1.17	-38.89
Staphylea trifolia	0	0.00	-4.96	-21.83
Toxicodendron radicans	3	17.65	-2.42	-18.07
Trillium recurvatum	0	0.00	-1.00	-80.00
Ulmus rubra	10	18.18	-0.96	-2.01
Viola pratincola	3	300.00	-0.08	-33.33
Zanthoxylem americanum	0	0.00	-1.00	-80.00

D. MIXED II - Species that decreased or remained same in frequency but increased in % cover (17 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Bidens frondosa	-1	-16.67	0.38	42.86
Botrychium virginicum	0	0.00	0.42	62.50
Campsis radicans	0	0.00	1.00	400.00
Cercis canadensis	-3	-21.43	0.08	1.96
Euonymus atropurpureus	0	0.00	3.88	193.75
Eupatorium serotinum	-3	-75.00	0.67	114.29
Fraxinus americana	0	0.00	1.00	400.00
Galium concinnum	-1	-14.29	0.75	29.51
Geranium maculatum	0	0.00	2.00	400.00
Leersia virginica	0	0.00	0.42	11.24
Lonicera maackii	-4	-19.05	4.17	51.02
Morus alba	-2	-66.67	0.71	130.77
Polygonum virginicum	-8	-29.63	2.13	29.48
Rhus aromatica	0	0.00	3.88	86.11
Silene stellata	0	0.00	0.88	10.24
Vernonia sp.	0	0.00	0.21	71.43
Viola triloba	0	0.00	1.42	170.00

E. NO CHANGE (1 Spp.)
Aplectrum hyemale

F. DECREASERS - Species that declined in both total cover and frequency (23 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Asplenium platyneuron	-1	-50.00	-0.04	-14.29
Carex cephalophora	-3	-25.00	-3.04	-33.95
Carex laxiflora	-4	-80.00	-1.00	-44.44
Carex sp. (glabrous, 3 mm)	-3	-60.00	-0.96	-76.67
Carex sp. (seedling)	-2	-66.67	-0.29	-87.50
Carya ovata	-2	-50.00	-0.08	-14.29
Celastris scandens	-1	-20.00	-1.25	-38.46

Table 8 continued.

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Cornus racemosa	-1	-33.33	-0.25	-14.29
Elymus virginicus	-2	-33.33	-4.58	-62.15
Eupatorium altissimum	-1	-100.00	-0.25	-100.00
Galium triflorum	-1	-20.00	-0.92	-26.19
Helianthus strumosus	-1	-3.70	-13.92	-18.49
Impatiens capensis	-7	-19.44	-35.17	-72.38
Monarda bradburiana	-1	-50.00	-0.25	-16.67
Parthenocissus quinquefolia	-13	-11.30	-20.50	-20.31
Penstemon calycosa	-2	-66.67	-0.29	-53.85
Poa pratensis	-1	-100.00	-1.25	-100.00
Podophyllum peltatum	-3	-60.00	-5.63	-69.23
Sassafras albicans	-3	-27.27	-3.79	-38.72
Solidago canadensis	-2	-50.00	-0.29	-36.84
Solidago ulmifolia	-1	-5.00	-2.21	-9.17
Vitis riparia	-1	-4.00	0.33	7.41
Woodsia obtusa	-1	-100.00	-1.25	-100.00

G. EXTIRPATED - Species that were present at baseline and absent in final sample (15 Spp.)

SPECIES	Occur. #	Summed % Cover
Agastache nepetoides	-2	-0.50
Aristolochia serpentaria	-2	-0.50
Aster ontarionis	-1	-0.25
Botrychium dissectum var. *obliquum*	-2	-0.08
Cacalia atriplicifolia	-1	-0.04
Campanula americana	-4	-5.67
Corylus americana	-1	-1.25
Dichanthelium acuminatum	-1	-0.04
Erigeron annuus	-1	-0.25
Galium aparine	-1	-0.04
Hydrophyllum virginianum	-1	-1.25
Ipomoea sp.	-1	-0.25
Muhlenbergia schreberi	-1	-0.04
Quercus velutina	-1	-0.04
Rubus flagellaris	-1	-0.25

Table 9. Ground-Cover response types in fire-free reference plots at Beaver Dam State Park. Sample size of reference plots was 156 quadrats.

A. INCREASERS - Species that increased in cover and frequency (13 spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Carex blanda	8	200.00	2.58	258.33
Cryptotaenia canadensis	6	200.00	0.67	200.00
Cystopteris protrusa	4	80.00	4.00	384.00
Galium circaezans	2	18.18	5.33	355.56
Lonicera maackii	1	10.00	2.54	26.07
Parietaria pensylvanica	3	300.00	0.13	300.00
Parthenocissus quinquefolia	3	2.78	6.96	2.61
Prunus serotina	2	33.33	6.33	434.29
Quercus alba	1	100.00	0.25	100.00
Rosa multiflora	1	20.00	1.67	58.82
Rubus flagellaris	1	33.33	1.46	94.59
Staphylea trifolia	1	100.00	1.25	100.00
Viola pratincola	1	20.00	0.04	10.00

B. NEW SPECIES - Species that emerged during the study but were absent at baseline (13 Spp.)

SPECIES	Occur. #	Summed % Cover
Acalypha rhomboidea	2	0.08
Acalypha virginica	6	0.46
Aster simplex	4	0.58
Carya tomentosa	2	1.29
Dichanthelium clandestinum	4	1.58
Galium aparine	4	2.00
Juniperus virginiana	1	0.04
Leersia virginica	2	0.50
Oxalis dillenii/stricta	3	0.75
Quercus imbricaria	1	0.25
Ranunculus abortivus	1	0.04
Rhus aromatica	1	0.25
Smilax ecirrhata	1	1.25

C. MIXED I - Species that increased or remained same in frequency but decreased in % cover (8 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Carya ovata	1	33.33	-0.54	-21.31
Cercis canadensis	3	27.27	-1.29	-56.36
Circaea lutetiana	14	43.75	-4.51	-18.45
Cornus drummondii	0	0.00	-1.00	-80.00
Elymus virginicus	0	0.00	-1.00	-66.67
Festuca obtusa	2	14.29	-5.29	-53.59
Symphoricarpos orbiculatus	0	0.00	-2.67	-57.14
Toxicodendron radicans	0	0.00	-3.42	-75.93

Table 9 continued

D. MIXED II - Species that decreased or remained same in frequency but increased in % cover (16 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Agrimonia pubescens	-6	-75.00	0.25	7.41
Aristolochia serpentaria	-2	-50.00	1.71	215.79
Botrychium virginicum	-7	-70.00	0.08	5.71
Carex radiata	0	0.00	6.38	45.95
Carya cordiformis	0	0.00	1.00	400.00
Celastris scandens	0	0.00	1.00	36.36
Celtis occidentalis	-1	-4.76	4.58	129.41
Cinna arundinacea	-2	-20.00	1.79	29.45
Galium concinnum	0	0.00	1.00	133.33
Geum canadense	-5	-16.67	2.21	38.41
Osmorhiza longistylis	-1	-50.00	0.96	328.57
Phlox divaricata	0	0.00	0.21	500.00
Quercus velutina	-1	-33.33	0.96	176.92
Smilax hispida	0	0.00	1.29	31.31
Solidago ulmifolia	0	0.00	4.08	124.05
Vitis riparia	-7	-46.67	0.08	5.71

E. NO CHANGE (3 Spp.)

Euonymus atropurpureus
Phytolacca americana
Veronicastrum virginicum

F. DECREASERS - Species that declined in both total cover and frequency (28 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Arisaema triphyllum	-3	-60.00	-0.54	-29.55
Aster ontarionis	-2	-50.00	-1.29	-72.09
Bidens frondosa	-1	-25.00	-0.04	-5.26
Carex hirtifolia	-2	-28.57	-4.38	-41.67
Cornus racemosa	-1	-33.33	-1.25	-45.45
Desmodium glutinosum	-2	-40.00	-0.67	-47.06
dicot 3 seedling	-2	-66.67	-0.08	-66.67
Diospyros virginiana	-1	-50.00	-0.04	-14.29
Elymus villosus	-1	-33.33	-1.25	-22.22
Eupatorium rugosum	-22	-36.07	-21.00	-52.45
Fraxinus americana	-1	-33.33	-1.04	-40.98
Galium triflorum	-2	-28.57	-1.08	-34.67
Hackelia virginica	-2	-33.33	-0.29	-63.64
Impatiens capensis	-2	-16.67	-3.92	-59.49
Menispermum canadense	-1	-100.00	-1.25	-100.00
Oxalis fontana	-2	-100.00	-0.08	-100.00
Phryma leptostachya	-6	-40.00	-2.04	-32.45
Pilea pumila	-14	-46.67	-5.13	-75.00

Table 9 continued

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Poa sylvestris	-3	-25.00	-1.50	-16.67
Polygonum virginicum	-10	-35.71	-0.21	-3.03
Ribes missouriense	-1	-16.67	-0.25	-5.56
Rubus pensylvanicus	-1	-14.29	-0.04	-0.92
Sanicula odorata	-5	-6.85	-10.50	-5.76
Smilacina racemosa	-2	-66.67	-1.50	-85.71
Teucrium canadense	-1	-33.33	-0.04	-2.70
Trillium recurvatum	-1	-100.00	-0.04	-100.00
Ulmus rubra	-7	-12.07	-16.75	-20.16
Viola sororia	-4	-21.05	-1.17	-18.54

G. EXTIRPATED - Species that were present at baseline and absent in final sample (19 Spp.)

SPECIES	Occur. #	Summed % Cover
Asplenium platyneuron	-1	-0.25
Aster lateriflorus	-2	-0.50
Bromus pubescens	-1	-0.25
Campanula americana	-1	-1.25
Cardamine parviflora	-1	-0.04
Carex cephalophora	-1	-1.25
Carex grisea	-3	-1.75
Carex laxiflora	-3	-2.75
Carex sp. (seedling)	-2	-0.50
Dichanthelium boscii	-2	-0.50
Eupatorium purpureum	-1	-0.25
Polygonatum commutatum	-2	-0.29
Polygonum sp.	-1	-0.04
Prenanthes sp.	-1	-1.25
Ptelea trifoliata	-1	-1.25
Quercus rubra	-5	-1.04
Sanicula canadensis	-3	-13.54
Sassafras albicans	-3	-0.13
Smilax lasioneuron	-1	-1.25

Table 10. Summary data for all vegetation strata at Chip-O-Will Woods including baseline and post-treatment data.

		CANOPY STRATUM				SHRUB-SAPLING STRATUM			GROUND-COVER STRATUM				
UNIT	YEAR	Basal Area (m2/ha)	Tree Denstiy/ha	Total Species Richness	Mean Specics Richness	Stem Denstiy/ha	Total Species Richness	Mean Species Richness	Total Species Richness	Avg. Spp/.Tran-sect	Species Density/quadrat	% Cover	% Bare Ground
Unit B	2003	24.1	548.9	11	5.2	4,433.3	17	4.7	48	10.0	1.9	20.7	79.7
	2004	24.3	546.7	12	5.3	1,144.4	14	2.8	56	14.7	3.1	19.7	78.1
Unit C	2003	28.3	597.8	16	4.8	3,711.1	24	6.8	32	7.4	1.4	20.0	79.1
	2004	28.3	602.2	16	4.9	1,477.8	20	4.3	39	9.4	2.0	19.3	81.4
Unit D*	2003	25.7	462.2	15	5.7	7,077.8	27	10.7	51	12.3	2.2	22.2	76.4
	2004	25.9	468.9	18	6.1	6,022.2	25	10.0	46	10.7	1.9	25.5	75.9

*Units D1 and D2 combined to equalize sample size with Unit B and Unit C (9 tree plots each)

Table 11. Baseline tree data from all plots combined and, separately, fire-treatment and fire-free control plots at Chip-O-Will Woods.

	ALL PLOTS COMBINED (n = 27)				FIRE TREATMENT PLOTS (n = 17)				CONTROL PLOTS (n = 10)			
All 27 Plots	**Total Density**	**Basal Area**	**% Freq-**	**IV 300**	**Total Density**	**Basal Area**	**% Freq-**	**IV300**	**Total Density**	**Basal Area**	**% Freq-**	**IV300**
Tree Species	**per ha**	**m^2/ha**	**uency**		**per ha**	**m^2/ha**	**uency**		**per ha**	**m^2/ha**	**uency**	
Quercus stellata	275.6	22.536	100.0	156.9	282.35	22.655	17	154.78	264	22.335	10	161.28
Carya ovata	62.2	0.913	63.0	27.2	80.00	1.224	12	32.30	32	0.384	5	17.63
Ulmus rubra	59.3	0.376	74.1	26.7	58.82	0.384	13	26.54	60	0.363	7	27.18
Quercus marilandica	45.2	0.913	70.4	25.4	41.18	0.745	11	22.54	52	1.198	8	30.65
Quercus velutina	28.1	0.183	37.0	13.0	40.00	0.248	7	15.91	8	0.073	3	7.62
Quercus bicolor	12.6	0.807	18.5	9.0	8.24	0.646	2	6.17	20	1.080	3	14.06
Diospyros virginiana	6.7	0.042	29.6	7.1	4.71	0.033	4	5.50	10	0.058	4	9.86
Quercus palustris	8.9	0.096	18.5	5.6	11.76	0.135	4	7.12	4	0.031	1	2.84
Carya tomentosa	7.4	0.068	14.8	4.5	10.59	0.105	3	5.66	2	0.005	1	2.33
Prunus serotina	5.2	0.039	14.8	4.0	7.06	0.054	3	4.85	2	0.012	1	2.35
Quercus imbricaria	3.0	0.021	14.8	3.5	2.35	0.024	2	2.78	4	0.014	2	4.67
Celtis occidentalis	2.2	0.015	11.1	2.6	2.35	0.021	2	2.76	2	0.005	1	2.33
Carya texana	3.7	0.010	7.4	2.1	5.88	0.016	2	3.36	0	0.000	0	0.00
Sassafras albidum	3.0	0.011	7.4	2.0	0.00	0.000	0	0.00	8	0.030	2	5.57
Gleditsia triacanthos	1.5	0.005	7.4	1.7	1.18	0.002	1	1.35	2	0.010	1	2.34
Acer negundo	1.5	0.005	7.4	1.7	1.18	0.005	1	1.36	2	0.004	1	2.32
Carya laciniosa	1.5	0.003	7.4	1.7	0.00	0.000	0	0.00	4	0.009	2	4.64
Cercis canadensis	3.7	0.012	3.7	1.4	5.88	0.019	1	2.24	0	0.000	0	0.00
Quercus rubra	2.2	0.016	3.7	1.2	3.53	0.025	1	1.85	0	0.000	0	0.00
Crataegus sp.	1.5	0.004	3.7	1.0	2.35	0.006	1	1.57	0	0.000	0	0.00
Celtis laevigata	0.7	0.002	3.7	0.9	0.00	0.000	0	0.00	2	0.007	1	2.33
Fraxinus americana	0.7	0.002	3.7	0.9	1.18	0.003	1	1.36	0	0.000	0	0.00
Crataegus crus-galli	0.0	0.000	0.0	0.0	0.00	0.000	0	0.00	0	0.000	0	0.00
Quercus stellata x *bicolor*	0.0	0.000	0.0	0.0	0.00	0.000	0	0.00	0	0.000	0	0.00
TOTAL	**536.30**	**26.08**		**300.00**	**570.59**	**26.35**		**300.00**	**478.00**	**25.62**		**300.00**
Species Richness	**22**				**19**				**17**			

Table 12. Baseline data from the shrub-sapling stratum (stems < 5 cm dbh, > 50 cm tall). Chip-O-Will Woods, Washington County, Illinois.

SPECIES	density/ha	% frequency	IV 200	treatment plot density/ha	control plots density/ha
Rubus flagellaris	1274.07	18	34.15	1670.59	600
Rubus pensylvanicus	1140.74	12	28.51	1105.88	1200
Toxicodendron radicans	770.37	10	20.21	64.71	1970
Quercus stellata	311.11	14	13.17	382.35	190
Fraxinus pennsylvanicus	122.22	14	9.44	76.47	200
Quercus palustris	107.41	14	9.15	82.35	150
Quercus marilandica	125.93	13	9.01	123.53	130
Ulmus rubra	103.70	12	8.07	58.82	180
Diospyros virginiana	85.19	9	6.20	88.24	80
Carya ovata	40.74	10	5.83	35.29	50
Quercus velutina	88.89	7	5.27	123.53	30
Sassafras albidum	133.33	5	5.14	5.88	350
Rosa setigera	181.48	2	4.58	35.29	430
Prunus serotina	59.26	6	4.18	41.18	90
Campsis radicans	133.33	3	4.14	170.59	70
Celtis occidentalis	51.85	6	4.04	35.29	80
Rosa multiflora	66.67	5	3.83	0.00	180
Quercus bicolor	62.96	5	3.75	17.65	140
Ilex decidua	40.74	5	3.32	0.00	110
Acer negundo	33.33	5	3.17	23.53	50
Parthenocissus quinquefolia	18.52	4	2.38	5.88	40
Quercus rubra	25.93	3	2.02	41.18	0
Smilax hispida	22.22	3	1.95	0.00	60
Vitis riparia	22.22	3	1.95	11.76	40
Vitis cinerea	7.41	2	1.15	0.00	20
Carya laciniosa	7.41	1	0.65	0.00	20
Carya texana	7.41	1	0.65	11.76	0
Cercis canadensis	7.41	1	0.65	11.76	0
Celtis laevigata	3.70	1	0.58	5.88	0
Crataegus crus-galli	3.70	1	0.58	0.00	10
Crataegus sp. cuneate leaf base	3.70	1	0.58	5.88	0
Euonymus atropurpureus	3.70	1	0.58	0.00	10
Prunus sp.	3.70	1	0.58	5.88	0
Quercus imbricaria	3.70	1	0.58	5.88	0
TOTALS	5,074.07		200.00	4,247.06	6,480.00
Mean Species Richness/0.01 ha	7.40				
Mean Stem Density/0.01 ha	50.74				

Table 13. Summary data from baseline (2003) ground-cover stratum samples in fire-treatment and reference units, Chip-O-Will Woods.

	occurr-ences (324 quadrats)	% freq-uency	avg. % Cover	IV200
Parthenocissus quinquefolia	97	29.9383	3.9599	35.4609
Rubus flagellaris	75	23.1481	3.5478	29.7392
Eleocharis verrucosa	19	5.8642	2.1512	13.5142
Quercus stellata	33	10.1852	0.9074	9.9642
Cinna arundinacaea	29	8.9506	0.6435	8.0215
Agrostis perennans	17	5.2469	0.7623	6.5411
Carex festucacea	13	4.0123	0.8380	6.2196
Carex glaucodea	17	5.2469	0.5478	5.5169
Acer saccharinum	24	7.4074	0.0833	4.4935
Leersia virginica	9	2.7778	0.5494	4.1591
Carex cf. *pellita*	9	2.7778	0.5463	4.1443
Impatiens capensis	15	4.6296	0.2654	3.8271
Helianthus strumosus	8	2.4691	0.4892	3.7011
Parthenium integrifolium	7	2.1605	0.4537	3.3609
Carex albicans	11	3.3951	0.2485	3.0635
Dichanthelium acuminatum	13	4.0123	0.1698	3.0290
Carex annectens	4	1.2346	0.4784	2.9669
Lonicera japonica	4	1.2346	0.4784	2.9669
Ulmus rubra	14	4.3210	0.0818	2.7796
Acalypha virginica/gracilens	15	4.6296	0.0309	2.7071
Quercus palustris	10	3.0864	0.0988	2.1781
Carex 1 sterile	2	0.6173	0.3781	2.1466
Galium obtusum	4	1.2346	0.2948	2.0900
Allium canadense	9	2.7778	0.0972	2.0001
Podophyllum peltatum	3	0.9259	0.2778	1.8383
Rubus sp.	9	2.7778	0.0602	1.8232
Vitis riparia	4	1.2346	0.2346	1.8026
Rubus pensilvanicus	5	1.5432	0.1898	1.7596
Toxicodendron radicans	5	1.5432	0.1744	1.6859
Carex caroliniana	4	1.2346	0.2099	1.6847
Diospyros virginiana	7	2.1605	0.0941	1.6440
Vitis cinerea	7	2.1605	0.0941	1.6440
Viola pratincola	8	2.4691	0.0201	1.4610
Polygonum cf. *hydropiperoides*	2	0.6173	0.2022	1.3066
Geum canadense	3	0.9259	0.1636	1.2930
Carya ovata	3	0.9259	0.1343	1.1530
Potentilla simplex	5	1.5432	0.0602	1.1406
Rosa setigera	3	0.9259	0.1265	1.1162
Oxalis stricta/dillenii	6	1.8519	0.0170	1.1049
Erechtites hieraciifolia	5	1.5432	0.0231	0.9638
Apocynum cannabinum	4	1.2346	0.0586	0.9626
Amphicarpaea bracteata	2	0.6173	0.1173	0.9013
Euthamia graminifolia	2	0.6173	0.0926	0.7834
Pycnanthemum tenuifolium	2	0.6173	0.0926	0.7834

Table 13 continued.

	occurrences (324 quadrats)	% frequency	avg. % Cover	IV200
Eleocharis wolfii	2	0.6173	0.0556	0.6066
Fraxinus pennsylvanica	3	0.9259	0.0046	0.5341
Tradescantia ohiensis	2	0.6173	0.0185	0.4297
Andropogon gerardii	1	0.3086	0.0463	0.3917
Carex cf. *cephaloidea*	1	0.3086	0.0463	0.3917
Muhlenbergia sp.	1	0.3086	0.0463	0.3917
Prunus serotina	1	0.3086	0.0463	0.3917
Sassafras albidum	1	0.3086	0.0463	0.3917
Acer rubrum	2	0.6173	0.0031	0.3560
Dicot seedling	2	0.6173	0.0031	0.3560
Parietaria pennsylvanica	2	0.6173	0.0031	0.3560
Dichanthelium villosissimum	1	0.3086	0.0093	0.2149
Ipomoea sp.	1	0.3086	0.0093	0.2149
Porteranthus stipulaceus	1	0.3086	0.0093	0.2149
Prunella vulgaris	1	0.3086	0.0093	0.2149
Quercus velutina	1	0.3086	0.0093	0.2149
Rosa multiflora	1	0.3086	0.0093	0.2149
Anagallis arvensis	1	0.3086	0.0015	0.1780
Celtis occidentalis	1	0.3086	0.0015	0.1780
Dicot seedling (cf. *Aster* sp.)	1	0.3086	0.0015	0.1780
Elymus virginicus	1	0.3086	0.0015	0.1780
Euphorbia corollata	1	0.3086	0.0015	0.1780
Lactuca canadensis	1	0.3086	0.0015	0.1780
Lindernia dubia var. *anagallidea*	1	0.3086	0.0015	0.1780
Lobelia inflata	1	0.3086	0.0015	0.1780
Ludwigia palustris	1	0.3086	0.0015	0.1780
Oxalis violacea	1	0.3086	0.0015	0.1780
Quercus imbricaria	1	0.3086	0.0015	0.1780
Quercus marilandica	1	0.3086	0.0015	0.1780
Quercus marilandica/velutina	1	0.3086	0.0015	0.1780
Solidago nemoralis	1	0.3086	0.0015	0.1780
Viola sagittata	1	0.3086	0.0015	0.1780
				200.0000

Mean species richness/transect	9.93
Mean species density/quadrat	1.81
Mean % Cover	20.9
Mean % Bare Ground	78.4

Table 14. Response categories for ground cover species at Chip-O-Will Woods comparing baseline to post-burn data in fire-treatment plots.

A. INCREASERS - Species that increased in cover and frequency (18 spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Acalypha virginica/gracilens	38	380.0	0.154	420.0
Dichanthelium acuminatum	28	400.0	0.154	370.6
Carex festucacea	23	255.6	0.870	93.9
Rubus flagellaris	20	44.4	0.811	19.7
Erechtites hieraciifolia	9	900.0	0.034	233.3
Oxalis stricta/dillenii	9	225.0	0.034	155.6
Quercus stellata	8	53.3	0.461	98.4
Porteranthus stipulaceus	6	600.0	0.002	16.7
Helianthus strumosus	5	83.3	0.380	49.2
Carex annectens	4	200.0	0.230	156.7
Carex caroliniana	4	400.0	0.169	230.0
Impatiens capensis	2	25.0	0.096	26.0
Rubus pensilvanicus	2	200.0	0.316	2,150.0
Carya ovata	1	50.0	0.002	8.3
Galium obtusum	1	50.0	0.015	16.7
Lobelia inflata	1	100.0	0.015	600.0
Viola pratincola	1	33.3	0.027	137.5
Viola sagittata	1	100.0	0.015	600.0

B. NEW SPECIES - Species that emerged during the study but were absent at baseline (22 Spp.)

SPECIES	Occur. #	Summed % Cover
Toxicodendron radicans	16	0.1471
Lactuca biennis	4	0.0221
Eupatorium serotinum	3	0.0074
Dicot seedling	2	0.0049
Phytolacca americana	2	0.0049
Polygonum punctatum	2	0.3211
Specularia perfoliata	2	0.0049
Brassicaceae (cf. *Rorippa*)	1	0.0025
Carex cf. *festucacea*	1	0.0025
Conyza canadensis	1	0.0025
Elymus virginicus	1	0.0147
Eupatorium rugosum	1	0.0025
Fabaceae 1 (cf. *Trifolium* sp.)	1	0.0025
Glyceria striata	1	0.0735
Lactuca sp.	1	0.0025
Leersia oryzoides	1	0.1838
Liatris pycnostachya	1	0.0147
Mimulus alatus	1	0.0147
Penstemon calycosus	1	0.0025
Physalis sp.	1	0.0025
Quercus velutina	1	0.0025

Table 14 continued.

Solidago juncea	1	0.0025

C. MIXED I - Species that increased occurrence number but decreased in % cover (7 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Agrostis perennans	11	91.7	-0.29	-24.6
Carex albicans	6	75.0	-0.02	-9.9
Carex glaucodea	13	76.5	-0.05	-5.6
Cinna arundinacaea	4	25.0	-0.06	-11.4
Geum canadense	3	100.0	-0.17	-67.0
Leersia virginica	2	33.3	-0.14	-25.6
Prunus serotina	5	500.0	-0.03	-46.7

D. MIXED II - Species that decreased in occurrences but increased in % cover (2 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Quercus palustris	-3	-60.0	0.06	260.0
Vitis cinerea	-2	-33.3	0.04	30.9

E. NO CHANGE - Species that had no change in occurrence number (8 Spp.)

SPECIES	Change in Occur. #	Change in % Cover	% change
Dicot seedling (cf. *Aster* sp.)	0	0.00	0.0
Eleocharis verrucosa	0	-0.80	-35.1
Euphorbia corollata	0	0.00	0.0
Ludwigia palustris	0	0.00	0.0
Muhlenbergia cf. *sobolifera*	0	0.00	0.0
Parietaria pennsylvanica	0	0.01	250.0
Rosa multiflora	0	0.06	400.0
Ulmus rubra	0	0.01	10.6
Vitis riparia	0	-0.34	-90.8

F. DECREASERS - Decline in frequency and % cover (7 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Parthenocissus quinquefolia	-12	-21.1	-1.473	-38.1
Potentilla simplex	-1	-33.3	-0.015	-16.2
Apocynum cannabinum	-1	-50.0	-0.002	-3.2
Diospyros virginiana	-2	-50.0	-0.076	-72.1
Podophyllum peltatum	-2	-66.7	-0.426	-96.7
Allium canadense	-4	-80.0	-0.022	-60.0
Acer saccharinum	-11	-84.6	-0.051	-75.0

G. EXTIRPATED - Species that were extirpated from samples (10 Spp.)

Table 14 continued.

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Acer rubrum	-2	-100.0	-0.005	-100.0
Carex 1 sterile	-2	-100.0	-0.600	-100.0
Fraxinus pennsylvanica	-2	-100.0	-0.005	-100.0
Polygonum cf. *hydropiperoides*	-2	-100.0	-0.321	-100.0
Quercus marilandica	-2	-100.0	-0.004902	-100.0
Celtis occidentalis	-1	-100.0	-0.002	-100.0
Lindernia dubia var. *anagallidec*	-1	-100.0	-0.002	-100.0
Parthenium integrifolium	-1	-100.0	-0.002	-100.0
Prunella vulgaris	-1	-100.0	-0.015	-100.0
Pycnanthemum tenuifolium	-1	-100.0	-0.074	-100.0

Table 15. Response categories for ground cover species at Chip-O-Will Woods comparing 2003 to 2004 data in fire-free reference plots.

A. INCREASERS - Species that increased in cover and frequency (9 spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Agrostis perennans	3	60.0	0.396	633.3
Fraxinus pennsylvanica	3	300.0	0.075	1800.0
Toxicodendron radicans	3	60.0	0.088	18.6
Carex albicans	2	66.7	0.050	13.3
Helianthus strumosus	2	100.0	0.250	3000.0
Lonicera japonica	2	50.0	0.317	24.5
Carex annectens	1	50.0	0.125	12.0
Carex caroliniana	1	33.3	0.542	122.6
Galium obtusum	1	50.0	0.125	19.4

B. NEW SPECIES - Species that emerged during the study but were absent at baseline (8 Spp.)

SPECIES	Occur. #	Summed % Cover
Eupatorium rugosum	1	0.004
Houstonia lanceolata	1	0.004
Juncus tenuis	1	0.025
Penstemon digitalis	1	0.004
Quercus bicolor	1	0.125
Rosa multiflora	1	0.125
Rubus sp.	1	0.004
Vitis riparia	1	0.025

C. MIXED I - Species that increased occurrence number but decreased in % cover (2 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Leersia virginica	1	33.3	-0.413	-72.3
Parthenocissus quinquefolia	1	2.5	-0.025	-0.6

D. MIXED II - Species that decreased in occurrences but increased in % cover (8 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Acalypha virginica/gracilens	-4	-80.0	0.004	20.0
Acer saccharinum	-5	-45.5	0.100	92.3
Amphicarpaea bracteata	-1	-50.0	0.204	64.5
Cinna arundinacaea	-3	-23.1	0.317	38.6
Dichanthelium acuminatum	-2	-33.3	0.200	51.6
Impatiens capensis	-3	-42.9	0.008	9.1
Rubus flagellaris	-2	-6.7	0.646	25.0
Viola pratincola	-1	-20.0	0.038	180.0

Table 15 continued.

E. NO CHANGE - Species that had no change in occurrence number (12 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Anagallis arvensis	0	0.0	0.000	0.0
Andropogon gerardii	0	0.0	0.188	150.0
Carex festucacea	0	0.0	0.792	115.2
Carya ovata	0	0.0	0.000	0.0
Diospyros virginiana	0	0.0	0.079	105.6
Eleocharis verrucosa	0	0.0	-0.704	-36.1
Euthamia graminifolia	0	0.0	-0.200	-80.0
Oxalis stricta/dillenii	0	0.0	0.042	500.0
Pycnanthemum tenuifolium	0	0.0	0.000	0.0
Quercus palustris	0	0.0	0.100	44.4
Rosa setigera	0	0.0	0.221	64.6
Tradescantia ohiensis	0	0.0	0.200	400.0

F. DECREASERS - Decline in frequency and % cover (9 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Quercus stellata	-8	-44.4	-0.900	-54.4
Carex cf. *pellita*	-3	-33.3	-0.054	-3.7
Allium canadense	-2	-50.0	-0.150	-75.0
Rubus pensilvanicus	-2	-50.0	-0.238	-48.7
Ulmus rubra	-2	-33.3	-0.008	-33.3
Apocynum cannabinum	-1	-50.0	-0.004	-14.3
Eleocharis wolfii	-1	-50.0	-0.125	-83.3
Erechtites hieraciifolia	-1	-25.0	-0.004	-11.1
Parthenium integrifolium	-1	-16.7	-0.200	-16.4

G. EXTIRPATED - Species that were extirpated from samples (13 Spp.)

SPECIES	Change in Occur. #	% freq change	Change in % Cover	% change
Dicot seedling	-2	-100.0	-0.008	-100.0
Potentilla simplex	-2	-100.0	-0.008	-100.0
Carex cf. *cephaloidea*	-1	-100.0	-0.125	-100.0
Dichanthelium villosissimum	-1	-100.0	-0.025	-100.0
Elymus virginicus	-1	-100.0	-0.004	-100.0
Ipomoea sp.	-1	-100.0	-0.025	-100.0
Lactuca canadensis	-1	-100.0	-0.004	-100.0
Oxalis violacea	-1	-100.0	-0.004	-100.0
Quercus imbricaria	-1	-100.0	-0.004	-100.0
Quercus velutina	-1	-100.0	-0.025	-100.0
Sassafras albidum	-1	-100.0	-0.125	-100.0
Solidago nemoralis	-1	-100.0	-0.004	-100.0
Vitis cinerea	-1	-100.0	-0.025	-100.0

Appendix 1. Summary canopy data from each sample unit at Beaver Dam State Park.

Baseline (2003) Data	**Total BA/Spp per ha**	**Relative Basal Area**	**Total Density per ha**	**Relative Density**	**IV200**
Unit 12					
Acer negundo					
Carya cordiformis	0.31	1.10	6.67	0.95	2.04
Carya ovalis					
Carya ovata	3.65	12.94	83.33	11.85	24.79
Carya tomentosa	0.06	0.22	13.33	1.90	2.12
Celtis occidentalis	1.06	3.77	63.33	9.00	12.77
Cercis canadensis	0.79	2.79	86.67	12.32	15.11
Diospyros virginiana					
Fraxinus americana	0.08	0.27	6.67	0.95	1.22
Gleditsia triacanthos	1.23	4.35	13.33	1.90	6.25
Juglans nigra	0.26	0.93	6.67	0.95	1.88
Liquidambar styraciflua					
Maclura pomifera	0.04	0.14	3.33	0.47	0.61
Morus alba					
Morus rubra	0.02	0.07	6.67	0.95	1.02
Prunus serotina	0.24	0.86	16.67	2.37	3.23
Quercus alba	8.33	29.55	70.00	9.95	39.50
Quercus bicolor					
Quercus imbricaria	0.03	0.10	3.33	0.47	0.57
Quercus macrocarpa	3.46	12.27	6.67	0.95	13.22
Quercus muhlenbergii					
Quercus rubra	0.32	1.15	10.00	1.42	2.57
Quercus stellata	3.12	11.05	13.33	1.90	12.95
Quercus velutina	2.51	8.91	26.67	3.79	12.70
Sassafras albidum					
Ulmus americana					
Ulmus rubra	2.68	9.51	263.33	37.44	46.95
Vitis cinerea					
Vitis riparia					
Vitis sp.	0.01	0.03	3.33	0.47	0.50
		100.00		100.00	200.00

SUMMARY DATA		
Species #	19	
Avg. Richness/0.05-ha	8	
Tree Density/ha	703.00	
Avg. Tree Density/0.05-ha	35.16	
Basal Area (m^2/ha)	28.19	
Avg. Basal Area (m^2/0.05 ha)	1.41	
	sum IV	
***Quercus/Carya* dominance**	**200**	**% IV**
***Quercus* spp**	81.52	40.76
***Carya* spp**	28.95	14.48
SUM	110.47	55.23

Appendix 1 continued.

Baseline (2003) Data Unit 18	Total BA/Spp per ha	Relative Basal Area	Total Density per ha	Relative Density	IV200
Acer negundo					
Carya cordiformis	0.471239	1.8263398	6.666667	0.862069	2.688409
Carya ovalis					
Carya ovata	1.726754	6.6922368	73.33334	9.482759	16.175
Carya tomentosa	0.102625	0.3977362	6.666667	0.862069	1.259805
Celtis occidentalis	1.329348	5.1520438	140	18.10345	23.25549
Cercis canadensis	0.036594	0.1418254	13.33333	1.724138	1.865963
Diospyros virginiana					
Fraxinus americana	0.14778	0.5727402	6.666667	0.862069	1.434809
Gleditsia triacanthos					
Juglans nigra	0.907846	3.518464	13.33333	1.724138	5.242602
Liquidambar styraciflua					
Maclura pomifera					
Morus alba					
Morus rubra	0.063355	0.2455412	6.666667	0.862069	1.10761
Prunus serotina	0.564539	2.1879348	20	2.586207	4.774142
Quercus alba	3.092492	11.985315	33.33334	4.310345	16.29566
Quercus bicolor					
Quercus imbricaria					
Quercus macrocarpa	0.634565	2.4593289	13.33333	1.724138	4.183467
Quercus muhlenbergii	3.89709	15.103628	46.66667	6.034483	21.13811
Quercus rubra	0.41757	1.61834	26.66667	3.448276	5.066616
Quercus stellata	6.827089	26.45918	40	5.172414	31.63159
Quercus velutina	4.090534	15.85334	40	5.172414	21.02575
Sassafras albidum	0.396066	1.534998	86.66667	11.2069	12.74189
Ulmus americana					
Ulmus rubra	0.99669	3.8627899	180	23.27586	27.13865
Vitis cinerea					
Vitis riparia					
Vitis sp.	0.10017	0.388219	20	2.586207	2.974426
		100		100	200

SUMMARY DATA		
Species #	18	
Avg. Richness/0.05-ha	11.00	
Tree Density/ha	773.33	
Avg. Tree Density/0.05-ha	38.67	
Basal Area (m^2/ha)	25.80	
Avg. Basal Area (m^2/0.05 ha)	1.29	
***Quercus/Carya* dominance**	**sum IV 200**	**% IV**
***Quercus* spp**	99.34	49.67
***Carya* spp**	20.12	10.06
SUM	119.46	59.73

Appendix 1 continued.

Baseline (2003) Data Unit 4	Total BA/Spp per ha	Relative Basal Area	Total Density per ha	Relative Density	IV200
Acer negundo					
Carya cordiformis					
Carya ovalis	0.17	0.59	6.67	1.01	1.60
Carya ovata	1.55	5.55	40.00	6.06	11.61
Carya tomentosa	0.88	3.14	20.00	3.03	6.17
Celtis occidentalis	3.44	12.27	153.33	23.23	35.50
Cercis canadensis	0.95	3.40	80.00	12.12	15.53
Diospyros virginiana					
Fraxinus americana					
Gleditsia triacanthos					
Juglans nigra					
Liquidambar styraciflua					
Maclura pomifera	0.02	0.08	6.67	1.01	1.09
Morus alba					
Morus rubra					
Prunus serotina	0.15	0.53	6.67	1.01	1.54
Quercus alba	1.49	5.32	93.33	14.14	19.46
Quercus bicolor					
Quercus imbricaria	0.44	1.57	6.67	1.01	2.58
Quercus macrocarpa					
Quercus muhlenbergii	0.93	3.33	26.67	4.04	7.37
Quercus rubra					
Quercus stellata	10.84	38.72	106.67	16.16	54.88
Quercus velutina	6.40	22.84	33.33	5.05	27.89
Sassafras albidum	0.04	0.14	6.67	1.01	1.15
Ulmus americana					
Ulmus rubra	0.71	2.52	73.33	11.11	13.63
Vitis cinerea					
Vitis riparia					
Vitis sp.					
	28.01	100.00	660.00	100.00	200.00

SUMMARY DATA		
Species #	14	
Avg. Richness/0.05-ha	8.33	
Tree Density/ha	660.00	
Avg. Tree Density/0.05-ha	33.00	
Basal Area (m^2/ha)	28.01	
Avg. Basal Area (m^2/0.05 ha)	1.40	
***Quercus/Carya* dominance**	**sum IV 200**	**% IV**
***Quercus* spp**	113.02	56.51
***Carya* spp**	17.92	8.96
SUM	130.94	65.47

Appendix 1 continued.

Baseline (2003) Data Unit 5	Total BA/Spp per ha	Relative Basal Area	Total Density per ha	Relative Density	IV200
Acer negundo					
Carya cordiformis					
Carya ovalis					
Carya ovata	1.29	4.95	50.00	6.22	11.17
Carya tomentosa	0.86	3.30	23.33	2.90	6.21
Celtis occidentalis	0.78	2.99	60.00	7.47	10.46
Cercis canadensis	0.51	1.97	33.33	4.15	6.12
Diospyros virginiana					
Fraxinus americana	0.01	0.06	3.33	0.41	0.47
Gleditsia triacanthos					
Juglans nigra					
Liquidambar styraciflua					
Maclura pomifera					
Morus alba					
Morus rubra					
Prunus serotina	2.43	9.37	46.67	5.81	15.18
Quercus alba	5.66	21.77	83.33	10.37	32.15
Quercus bicolor					
Quercus imbricaria					
Quercus macrocarpa					
Quercus muhlenbergii	0.02	0.07	3.33	0.41	0.49
Quercus rubra	1.75	6.73	13.33	1.66	8.39
Quercus stellata					
Quercus velutina	7.35	28.29	36.67	4.56	32.86
Sassafras albidum	0.64	2.47	80.00	9.96	12.42
Ulmus americana					
Ulmus rubra	4.63	17.83	350.00	43.57	61.40
Vitis cinerea					
Vitis riparia					
Vitis sp.	0.05	0.20	20.00	2.49	2.69
		100.00		100.00	200.00

SUMMARY DATA		
Species #	13	
Avg. Richness/0.05-ha	7.67	
Tree Density/ha	803.33	
Avg. Tree Density/0.05-ha	40.17	
Basal Area (m^2/ha)	25.99	
Avg. Basal Area (m^2/0.05 ha)	1.30	
***Quercus/Carya* dominance**	**sum IV 200**	**% IV**
***Quercus* spp**	73.88	36.94
***Carya* spp**	17.38	8.69
SUM	91.26	45.63

Appendix 1 continued.

Baseline (2003) Data Unit 7	Total BA/Spp per ha	Relative Basal Area	Total Density per ha	Relative Density	IV200
Acer negundo	0.02	0.08	3.33	0.36	0.44
Carya cordiformis					
Carya ovalis					
Carya ovata	1.14	4.78	26.67	2.89	7.67
Carya tomentosa	0.31	1.32	6.67	0.72	2.04
Celtis occidentalis	5.05	21.21	286.67	31.05	52.26
Cercis canadensis	0.31	1.31	30.00	3.25	4.56
Diospyros virginiana					
Fraxinus americana					
Gleditsia triacanthos	2.45	10.28	20.00	2.17	12.45
Juglans nigra	1.48	6.21	23.33	2.53	8.73
Liquidambar styraciflua	0.41	1.73	6.67	0.72	2.45
Maclura pomifera	0.71	2.98	23.33	2.53	5.50
Morus alba	0.29	1.20	13.33	1.44	2.65
Morus rubra	0.85	3.57	23.33	2.53	6.09
Prunus serotina	0.03	0.13	6.67	0.72	0.85
Quercus alba	0.03	0.11	3.33	0.36	0.47
Quercus bicolor	0.01	0.06	3.33	0.36	0.42
Quercus imbricaria	1.07	4.52	26.67	2.89	7.41
Quercus macrocarpa	1.02	4.30	10.00	1.08	5.38
Quercus muhlenbergii	1.08	4.55	80.00	8.66	13.22
Quercus rubra	0.39	1.66	20.00	2.17	3.82
Quercus stellata	0.40	1.70	10.00	1.08	2.78
Quercus velutina	3.16	13.30	20.00	2.17	15.47
Sassafras albidum	0.40	1.68	23.33	2.53	4.20
Ulmus americana	0.41	1.73	3.33	0.36	2.10
Ulmus rubra	2.72	11.43	236.67	25.63	37.06
Vitis cinerea					
Vitis riparia	0.04	0.18	16.67	1.81	1.99
Vitis sp.					
	23.79	100.00	923.33	100.00	200.00

SUMMARY DATA		
Species #	24	
Avg. Richness/0.05-ha	10.30	
Tree Density/ha	923.33	
Avg. Tree Density/0.05-ha	46.17	
Basal Area (m^2/ha)	23.79	
Avg. Basal Area (m^2/0.05 ha)	1.19	
***Quercus/Carya* dominance**	**sum IV 200**	**% IV**
***Quercus* spp**	48.96	24.48
***Carya* spp**	9.71	4.86
SUM	58.67	29.34

Appendix 1 continued.

Baseline (2003) Data Unit 15	Total BA/Spp per ha	Relative Basal Area	Total Density per ha	Relative Density	IV200
Acer negundo					
Carya cordiformis	0.07	0.32	20.00	2.27	2.60
Carya ovalis					
Carya ovata	3.04	13.29	180.00	20.45	33.74
Carya tomentosa	0.06	0.28	13.33	1.52	1.79
Celtis occidentalis	0.49	2.16	33.33	3.79	5.95
Cercis canadensis	0.21	0.94	46.67	5.30	6.24
Diospyros virginiana					
Fraxinus americana	0.31	1.34	6.67	0.76	2.10
Gleditsia triacanthos					
Juglans nigra					
Liquidambar styraciflua					
Maclura pomifera					
Morus alba					
Morus rubra	0.02	0.08	6.67	0.76	0.84
Prunus serotina	2.78	12.14	206.67	23.48	35.63
Quercus alba	5.51	24.11	46.67	5.30	29.42
Quercus bicolor					
Quercus imbricaria					
Quercus macrocarpa	1.56	6.80	6.67	0.76	7.56
Quercus muhlenbergii					
Quercus rubra	3.12	13.67	20.00	2.27	15.94
Quercus stellata	0.28	1.24	6.67	0.76	2.00
Quercus velutina	1.81	7.94	13.33	1.52	9.45
Sassafras albidum	0.21	0.92	26.67	3.03	3.95
Ulmus americana					
Ulmus rubra	3.33	14.58	233.33	26.52	41.09
Vitis cinerea	0.02	0.07	6.67	0.76	0.83
Vitis riparia	0.02	0.10	6.67	0.76	0.86
Vitis sp.					
		100.00		100.00	200.00

SUMMARY DATA		
Species #	17	
Avg. Richness/0.05-ha	10.33	
Tree Density/ha	880.00	
Avg. Tree Density/0.05-ha	44.00	
Basal Area (m^2/ha)	22.86	
Avg. Basal Area (m^2/0.05 ha)	1.14	
***Quercus/Carya* dominance**	**sum IV 200**	**% IV**
***Quercus* spp**	64.38	32.19
***Carya* spp**	38.13	19.07
SUM	102.51	51.25

Appendix 2. Shrub-Sapling stratum summary data for each unit at Beaver Dam State Park.

Baseline (2003) Data		**Releative**	**Total**	**Relative**	
Unit 12	**Frequency**	**Frequency**	**Density**	**Density**	**IV 200**
Species					
Acer negundo	25.00	2.94	13.00	2.03	4.98
Campsis radicans					
Carya cordiformis	25.00	2.94	4.00	0.63	3.57
Carya ovata	58.33	6.86	20.00	3.13	9.99
Carya tomentosa	25.00	2.94	8.00	1.25	4.19
Celastrus scandens					
Celtis occidentalis	83.33	9.80	70.00	10.95	20.76
Cercis canadensis	66.67	7.84	36.00	5.63	13.48
Cornus drummondii					
Cornus racemosa					
Corylus americana					
Crataegus crus-gallii					
Crataegus mollis					
Crataegus sp.					
Diospyros virginiana					
Elaeagnus angustifolia	8.33	0.98	1.00	0.16	1.14
Euonymus atropurpureus					
Fraxinus americana	100.00	11.76	41.00	6.42	18.18
Juglans nigra	8.33	0.98	1.00	0.16	1.14
Juniperus virginiana	16.67	1.96	2.00	0.31	2.27
Lindera benzoin					
Lonicera maackii	41.67	4.90	18.00	2.82	7.72
Malus ioensis					
Menispermum canadense					
Morus alba	16.67	1.96	2.00	0.31	2.27
Morus rubra					
Parthenocissus quinquefolia					
Prunus americana	8.33	0.98	1.00	0.16	1.14
Prunus serotina	33.33	3.92	9.00	1.41	5.33
Prunus sp.	8.33	0.98	1.00	0.16	1.14
Ptelea trifoliata					
Quercus alba	25.00	2.94	4.00	0.63	3.57
Quercus bicolor					
Quercus imbricaria					
Quercus macrocarpa					
Quercus muhlenbergii	8.33	0.98	1.00	0.16	1.14
Quercus rubra	16.67	1.96	2.00	0.31	2.27
Quercus velutina	8.33	0.98	2.00	0.31	1.29
Rhus aromatica					
Rhus glabra					
Ribes missouriense					
Rosa carolina					
Rosa multiflora	41.67	4.90	95.00	14.87	19.77
Rubus allegheniensis					
Rubus occidentalis					

Unit 12

Rubus pensylvanicus	25.00	2.94	7.00	1.10	4.04
Sambucus canadensis					
Sassafras albidum					
Smilax hispida	16.67	1.96	2.00	0.31	2.27
Staphylea trifolia					
Symphoricarpos orbiculatus	50.00	5.88	76.00	11.89	17.78
Toxicodendron radicans	25.00	2.94	4.00	0.63	3.57
Ulmus rubra	100.00	11.76	218.00	34.12	45.88
Viburnum prunifolium	8.33	0.98	1.00	0.16	1.14
Vitis cinerea					
Vitis riparia					
Vitis sp.					
Zanthoxylum americanum					
		100.00		100.00	200.00

SUMMARY DATA

Species Richness	26
Stems/ha	10,650
Avg. Density/0.005 ha	53.25

***Quercus/Carya* Dominance**	**sum IV**	**% IV**
Quercu s spp	8.27	4.14
Carya spp	17.75	8.88
SUM	26.02	13.01

Native Component	**sum IV**	**% IV**
Native	169.10	84.55
Adventive	30.90	15.45
		100.00

Appendix 2 continued.

Baseline (2003) Data Unit 18 Species	Frequency	Releative Frequency	Total Density	Relative Density	IV 200
Acer negundo					
Campsis radicans	16.67	1.52	2.00	0.26	1.78
Carya cordiformis	83.33	7.58	19.00	2.49	10.06
Carya ovata	50.00	4.55	5.00	0.65	5.20
Carya tomentosa					
Celastrus scandens					
Celtis occidentalis	100.00	9.09	93.00	12.17	21.26
Cercis canadensis	50.00	4.55	5.00	0.65	5.20
Cornus drummondii	33.33	3.03	3.00	0.39	3.42
Cornus racemosa					
Corylus americana					
Crataegus crus-gallii					
Crataegus mollis					
Crataegus sp.					
Diospyros virginiana					
Elaeagnus angustifolia					
Euonymus atropurpureus					
Fraxinus americana	66.67	6.06	11.00	1.44	7.50
Juglans nigra					
Juniperus virginiana					
Lindera benzoin	16.67	1.52	4.00	0.52	2.04
Lonicera maackii	33.33	3.03	2.00	0.26	3.29
Malus ioensis					
Menispermum canadense	16.67	1.52	2.00	0.26	1.78
Morus alba					
Morus rubra					
Parthenocissus quinquefolia	16.67	1.52	1.00	0.13	1.65
Prunus americana					
Prunus serotina	33.33	3.03	4.00	0.52	3.55
Prunus sp.					
Ptelea trifoliata					
Quercus alba	50.00	4.55	5.00	0.65	5.20
Quercus bicolor					
Quercus imbricaria					
Quercus macrocarpa					
Quercus muhlenbergii	33.33	3.03	3.00	0.39	3.42
Quercus rubra	16.67	1.52	1.00	0.13	1.65
Quercus velutina					
Rhus aromatica					
Rhus glabra					
Ribes missouriense	83.33	7.58	305.00	39.92	47.50
Rosa carolina					
Rosa multiflora	66.67	6.06	60.00	7.85	13.91
Rubus allegheniensis					
Rubus occidentalis					
Rubus pensylvanicus	50.00	4.55	9.00	1.18	5.72
Sambucus canadensis					

Appendix 2 continued.

Unit 18

Sassafras albidum	33.33	3.03	16.00	2.09	5.12
Smilax hispida	100.00	9.09	30.00	3.93	13.02
Staphylea trifolia					
Symphoricarpos orbiculatus					
Toxicodendron radicans	16.67	1.52	1.00	0.13	1.65
Ulmus rubra	100.00	9.09	181.00	23.69	32.78
Viburnum prunifolium	16.67	1.52	1.00	0.13	1.65
Vitis cinerea					
Vitis riparia	16.67	1.52	1.00	0.13	1.65
Vitis sp.					
Zanthoxylum americanum					
		100		100	200

SUMMARY DATA

Species Richness	24
Stems/ha	25,467
Avg. Density/0.005 ha	127.33

***Quercus/Carya* Dominance**	**sum IV**	**% IV**
Quercu s spp	10.27	5.13
Carya spp	15.26	7.63
SUM	25.53	12.77

Native Component	**sum IV**	**% IV**
Native	182.79	91.40
Adventive	17.21	8.60
		100.00

Appendix 2 continued.

Baseline (2003) Data Unit 4 Species	Frequency	Releative Frequency	Total Density	Relative Density	IV 200
Acer negundo					
Campsis radicans	33.33	5.26	5.00	1.54	6.80
Carya cordiformis					
Carya ovata					
Carya tomentosa	16.67	2.63	1.00	0.31	2.94
Celastrus scandens					
Celtis occidentalis	33.33	5.26	2.00	0.62	5.88
Cercis canadensis	83.33	13.16	12.00	3.69	16.85
Cornus drummondii					
Cornus racemosa					
Corylus americana					
Crataegus crus-gallii					
Crataegus mollis					
Crataegus sp.					
Diospyros virginiana					
Elaeagnus angustifolia					
Euonymus atropurpureus					
Fraxinus americana	50.00	7.89	7.00	2.15	10.05
Juglans nigra					
Juniperus virginiana					
Lindera benzoin					
Lonicera maackii					
Malus ioensis					
Menispermum canadense					
Morus alba					
Morus rubra					
Parthenocissus quinquefolia					
Prunus americana					
Prunus serotina	16.67	2.63	1.00	0.31	2.94
Prunus sp.					
Ptelea trifoliata	33.33	5.26	3.00	0.92	6.19
Quercus alba	16.67	2.63	1.00	0.31	2.94
Quercus bicolor					
Quercus imbricaria					
Quercus macrocarpa					
Quercus muhlenbergii					
Quercus rubra					
Quercus velutina					
Rhus aromatica	50.00	7.89	27.00	8.31	16.20
Rhus glabra	33.33	5.26	5.00	1.54	6.80
Ribes missouriense					
Rosa carolina					
Rosa multiflora	16.67	2.63	1.00	0.31	2.94
Rubus allegheniensis					
Rubus occidentalis					
Rubus pensylvanicus	33.33	5.26	30.00	9.23	14.49
Sambucus canadensis					

Unit 4

Sassafras albidum	33.33	5.26	130.00	40.00	45.26
Smilax hispida					
Staphylea trifolia					
Symphoricarpos orbiculatus					
Toxicodendron radicans					
Ulmus rubra	83.33	13.16	78.00	24.00	37.16
Viburnum prunifolium					
Vitis cinerea					
Vitis riparia	33.33	5.26	5.00	1.54	6.80
Vitis sp.					
Zanthoxylum americanum	66.67	10.53	17.00	5.23	15.76
	633.33	100.00	325.00	100.00	200.00

SUMMARY DATA

Species Richness	16
Stems/ha	10,833
Avg. Density/0.005 ha	54.17

***Quercus/Carya* Dominance**	**sum IV**	**% IV**
Quercu s spp	2.94	1.47
Carya spp	2.94	1.47
SUM	5.88	2.94

Native Component	**sum IV**	**% IV**
Native	197.06	98.53
Adventive	2.94	1.47
		100.00

Appendix 2 continued.

Baseline (2003) Data Unit 5 Species	Frequency	Releative Frequency	Total Density	Relative Density	IV 200
Acer negundo	8.33	0.93	2.00	0.34	1.27
Campsis radicans					
Carya cordiformis					
Carya ovata	8.33	0.93	1.00	0.17	1.10
Carya tomentosa	16.67	1.87	2.00	0.34	2.21
Celastrus scandens	8.33	0.93	1.00	0.17	1.10
Celtis occidentalis	83.33	9.35	60.00	10.15	19.50
Cercis canadensis	25.00	2.80	7.00	1.18	3.99
Cornus drummondii					
Cornus racemosa	16.67	1.87	2.00	0.34	2.21
Corylus americana	16.67	1.87	25.00	4.23	6.10
Crataegus crus-gallii					
Crataegus mollis	8.33	0.93	1.00	0.17	1.10
Crataegus sp.					
Diospyros virginiana					
Elaeagnus angustifolia					
Euonymus atropurpureus	8.33	0.93	1.00	0.17	1.10
Fraxinus americana	66.67	7.48	29.00	4.91	12.38
Juglans nigra	8.33	0.93	1.00	0.17	1.10
Juniperus virginiana					
Lindera benzoin					
Lonicera maackii	66.67	7.48	31.00	5.25	12.72
Malus ioensis					
Menispermum canadense	8.33	0.93	1.00	0.17	1.10
Morus alba	8.33	0.93	1.00	0.17	1.10
Morus rubra					
Parthenocissus quinquefolia					
Prunus americana					
Prunus serotina					
Prunus sp.					
Ptelea trifoliata	8.33	0.93	1.00	0.17	1.10
Quercus alba					
Quercus bicolor					
Quercus imbricaria					
Quercus macrocarpa					
Quercus muhlenbergii	8.33	0.93	1.00	0.17	1.10
Quercus rubra					
Quercus velutina					
Rhus aromatica	8.33	0.93	5.00	0.85	1.78
Rhus glabra					
Ribes missouriense	16.67	1.87	7.00	1.18	3.05
Rosa carolina					
Rosa multiflora	75.00	8.41	48.00	8.12	16.53
Rubus allegheniensis					
Rubus occidentalis	8.33	0.93	3.00	0.51	1.44
Rubus pensylvanicus	91.67	10.28	136.00	23.01	33.29
Sambucus canadensis	8.33	0.93	2.00	0.34	1.27

Unit 5

Sassafras albidum	75.00	8.41	19.00	3.21	11.63
Smilax hispida	25.00	2.80	3.00	0.51	3.31
Staphylea trifolia	25.00	2.80	127.00	21.49	24.29
Symphoricarpos orbiculatus	16.67	1.87	4.00	0.68	2.55
Toxicodendron radicans	25.00	2.80	3.00	0.51	3.31
Ulmus rubra	83.33	9.35	60.00	10.15	19.50
Viburnum prunifolium					
Vitis cinerea	16.67	1.87	2.00	0.34	2.21
Vitis riparia	25.00	2.80	3.00	0.51	3.31
Vitis sp.	8.33	0.93	1.00	0.17	1.10
Zanthoxylum americanum	8.33	0.93	1.00	0.17	1.10
		100.00		100.00	200.00

SUMMARY DATA

Species Richness	33
Stems/ha	9,850
Avg. Density/0.005 ha	49.25

***Quercus/Carya* Dominance**	**sum IV**	**% IV**
Quercu s spp	1.10	0.55
Carya spp	3.31	1.66
SUM	4.42	2.21

Native Component	**sum IV**	**% IV**
Native	169.64	84.82
Adventive	30.36	15.18
		100.00

Appendix 2 continued.

Baseline (2003) Data Unit 7 Species	Frequency	Releative Frequency	Total Density	Relative Density	IV 200
Acer negundo					
Campsis radicans					
Carya cordiformis	50.00	5.36	10.00	0.78	6.14
Carya ovata	16.67	1.79	2.00	0.16	1.94
Carya tomentosa	8.33	0.89	1.00	0.08	0.97
Celastrus scandens					
Celtis occidentalis	100.00	10.71	126.00	9.89	20.60
Cercis canadensis	25.00	2.68	4.00	0.31	2.99
Cornus drummondii					
Cornus racemosa					
Corylus americana	25.00	2.68	13.00	1.02	3.70
Crataegus crus-gallii	8.33	0.89	1.00	0.08	0.97
Crataegus mollis					
Crataegus sp.	8.33	0.89	1.00	0.08	0.97
Diospyros virginiana					
Elaeagnus angustifolia					
Euonymus atropurpureus	8.33	0.89	1.00	0.08	0.97
Fraxinus americana	33.33	3.57	10.00	0.78	4.36
Juglans nigra					
Juniperus virginiana					
Lindera benzoin					
Lonicera maackii	100.00	10.71	357.00	28.02	38.74
Malus ioensis	8.33	0.89	1.00	0.08	0.97
Menispermum canadense	16.67	1.79	6.00	0.47	2.26
Morus alba					
Morus rubra					
Parthenocissus quinquefolia	8.33	0.89	1.00	0.08	0.97
Prunus americana					
Prunus serotina	25.00	2.68	9.00	0.71	3.39
Prunus sp.	8.33	0.89	1.00	0.08	0.97
Ptelea trifoliata	8.33	0.89	2.00	0.16	1.05
Quercus alba					
Quercus bicolor					
Quercus imbricaria	8.33	0.89	1.00	0.08	0.97
Quercus macrocarpa					
Quercus muhlenbergii	50.00	5.36	21.00	1.65	7.01
Quercus rubra	33.33	3.57	6.00	0.47	4.04
Quercus velutina					
Rhus aromatica	16.67	1.79	2.00	0.16	1.94
Rhus glabra					
Ribes missouriense					
Rosa carolina					
Rosa multiflora	91.67	9.82	283.00	22.21	32.03
Rubus allegheniensis					
Rubus occidentalis	8.33	0.89	1.00	0.08	0.97
Rubus pensylvanicus					
Sambucus canadensis					

Appendix 2 continued.

Unit 7

Sassafras albidum	8.33	0.89	3.00	0.24	1.13
Smilax hispida	83.33	8.93	16.00	1.26	10.18
Staphylea trifolia	16.67	1.79	157.00	12.32	14.11
Symphoricarpos orbiculatus	33.33	3.57	90.00	7.06	10.64
Toxicodendron radicans	8.33	0.89	1.00	0.08	0.97
Ulmus rubra	91.67	9.82	144.00	11.30	21.12
Viburnum prunifolium					
Vitis cinerea					
Vitis riparia	16.67	1.79	2.00	0.16	1.94
Vitis sp.	8.33	0.89	1.00	0.08	0.97
Zanthoxylum americanum					
	933.33	100.00	1274.00	100.00	200.00

SUMMARY DATA

Species Richness	31
Stems/ha	21,233
Avg. Density/0.005 ha	106.17

***Quercus/Carya* Dominance**	**sum IV**	**% IV**
Quercu s spp	12.02	6.01
Carya spp	9.06	4.53
SUM	21.08	10.54

Native Component	**sum IV**	**% IV**
Native	129.23	64.61
Adventive	70.77	35.39
		100.00

Appendix 2 continued.

Baseline (2003) Data Unit 15 Species	Frequency	Releative Frequency	Total Density	Relative Density	IV 200
Acer negundo					
Campsis radicans					
Carya cordiformis	50.00	6.12	5.00	2.08	8.21
Carya ovata	16.67	2.04	1.00	0.42	2.46
Carya tomentosa					
Celastrus scandens					
Celtis occidentalis	100.00	12.24	23.00	9.58	21.83
Cercis canadensis	50.00	6.12	6.00	2.50	8.62
Cornus drummondii					
Cornus racemosa	16.67	2.04	2.00	0.83	2.87
Corylus americana					
Crataegus crus-gallii					
Crataegus mollis					
Crataegus sp.					
Diospyros virginiana					
Elaeagnus angustifolia					
Euonymus atropurpureus					
Fraxinus americana	50.00	6.12	8.00	3.33	9.46
Juglans nigra					
Juniperus virginiana					
Lindera benzoin					
Lonicera maackii	33.33	4.08	6.00	2.50	6.58
Malus ioensis					
Menispermum canadense					
Morus alba					
Morus rubra	16.67	2.04	1.00	0.42	2.46
Parthenocissus quinquefolia					
Prunus americana					
Prunus serotina	66.67	8.16	8.00	3.33	11.50
Prunus sp.					
Ptelea trifoliata					
Quercus alba					
Quercus bicolor					
Quercus imbricaria					
Quercus macrocarpa					
Quercus muhlenbergii					
Quercus rubra					
Quercus velutina					
Rhus aromatica					
Rhus glabra					
Ribes missouriense	100.00	12.24	49.00	20.42	32.66
Rosa carolina					
Rosa multiflora	66.67	8.16	20.00	8.33	16.50
Rubus allegheniensis					
Rubus occidentalis					
Rubus pensylvanicus	83.33	10.20	15.00	6.25	16.45
Sambucus canadensis					

Appendix 2 continued.

Unit 15

Sassafras albidum	50.00	6.12	5.00	2.08	8.21
Smilax hispida					
Staphylea trifolia					
Symphoricarpos orbiculatus					
Toxicodendron radicans					
Ulmus rubra	83.33	10.20	89.00	37.08	47.29
Viburnum prunifolium					
Vitis cinerea					
Vitis riparia	16.67	2.04	1.00	0.42	2.46
Vitis sp.					
Zanthoxylum americanum	16.67	2.04	1.00	0.42	2.46
	816.67	100.00	240.00	100.00	200.00

SUMMARY DATA

Species Richness	16
Stems/ha	8,000
Avg. Density/0.005 ha	40

***Quercus/Carya* Dominance**	**sum IV**	**% IV**
Quercu s spp	absent	absent
Carya spp	10.663265	5.3316327
SUM	10.663265	5.3316327

Native Component	**sum IV**	**% IV**
Native	176.92	88.46
Adventive	23.08	11.54
		100.00

Appendix 3. Baseline ground-cover data from each unit at Beaver Dam State Park.

Baseline (2003) Ground Cover Data - Unit 12	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Bare Ground	72	100.00		34.632		
Acalypha rhomboidea	0	0.00	0.00	0.000	0.000	0.000
Acalypha virginica	0	0.00	0.00	0.000	0.000	0.000
Acer saccharinum	0	0.00	0.00	0.000	0.000	0.000
Agastache nepetoides	0	0.00	0.00	0.000	0.000	0.000
Agrimonia pubescens	0	0.00	0.00	0.000	0.000	0.000
Agrimonia rostellata	4	5.56	1.27	0.264	0.396	1.662
Allium canadense	0	0.00	0.00	0.000	0.000	0.000
Amphicarpa bracteata	0	0.00	0.00	0.000	0.000	0.000
Aplectrum hyemale	0	0.00	0.00	0.000	0.000	0.000
Arisaema dracontium	0	0.00	0.00	0.000	0.000	0.000
Arisaema triphyllum	1	1.39	0.32	0.208	0.313	0.629
Aristolochia serpentaria	1	1.39	0.32	0.042	0.063	0.379
Asplenium platyneuron	0	0.00	0.00	0.000	0.000	0.000
Aster lateriflorus	2	2.78	0.63	0.083	0.125	0.758
Aster ontarionis	0	0.00	0.00	0.000	0.000	0.000
Aster pilosus	0	0.00	0.00	0.000	0.000	0.000
Aster simplex	0	0.00	0.00	0.000	0.000	0.000
Bidens cf. frondosa	0	0.00	0.00	0.000	0.000	0.000
Blephelia	0	0.00	0.00	0.000	0.000	0.000
Botrychium cf. obliquum	0	0.00	0.00	0.000	0.000	0.000
Botrychium virginicum	1	1.39	0.32	0.042	0.063	0.379
Bromus pubescens	1	1.39	0.32	0.042	0.063	0.379
Cacalia atriplicifolia	0	0.00	0.00	0.000	0.000	0.000
Calystegia sepium	0	0.00	0.00	0.000	0.000	0.000
Campanula americana	0	0.00	0.00	0.000	0.000	0.000
Campsis radicans	0	0.00	0.00	0.000	0.000	0.000
Cardamine parviflora	1	1.39	0.32	0.007	0.010	0.327
Carex albicans	0	0.00	0.00	0.000	0.000	0.000
Carex blanda	0	0.00	0.00	0.000	0.000	0.000
Carex cephalophora	1	1.39	0.32	0.208	0.313	0.629
Carex cf. grisea	1	1.39	0.32	0.208	0.313	0.629
Carex hirsutella	0	0.00	0.00	0.000	0.000	0.000
Carex hirtifolia	6	8.33	1.90	1.542	2.313	4.212
Carex jamesii	1	1.39	0.32	0.208	0.313	0.629
Carex laxiflora	0	0.00	0.00	0.000	0.000	0.000
Carex oligocarpa	0	0.00	0.00	0.000	0.000	0.000
Carex radiata	5	6.94	1.58	2.306	3.459	5.042
Carex sp. (glabrous, 3 mm)	0	0.00	0.00	0.000	0.000	0.000
Carex sp. (seedling)	0	0.00	0.00	0.000	0.000	0.000
Carya cordiformis	1	1.39	0.32	0.042	0.063	0.379
Carya ovata	2	2.78	0.63	0.417	0.625	1.258
Carya tomentosa	0	0.00	0.00	0.000	0.000	0.000
Celastris scandens	0	0.00	0.00	0.000	0.000	0.000
Celtis occidentalis	7	9.72	2.22	0.188	0.281	2.497
Cercis canadensis	9	12.50	2.85	0.333	0.500	3.348

Baseline (2003) Ground Cover Data - Unit 12	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Chenopodium album	0	0.00	0.00	0.000	0.000	0.000
Chenopodium standleyanum	0	0.00	0.00	0.000	0.000	0.000
Cinna arundinacea	0	0.00	0.00	0.000	0.000	0.000
Circaea lutetiana	17	23.61	5.38	3.458	5.189	10.569
Conyza canadensis	0	0.00	0.00	0.000	0.000	0.000
Cornus drummondii	0	0.00	0.00	0.000	0.000	0.000
Cornus racemosa	1	1.39	0.32	0.042	0.063	0.379
Corylus americana	0	0.00	0.00	0.000	0.000	0.000
Cryptotaenia canadensis	3	4.17	0.95	0.056	0.083	1.033
Cystopteris protrusa	5	6.94	1.58	0.174	0.260	1.843
Desmodium glutinosum	0	0.00	0.00	0.000	0.000	0.000
Dichanthelium acuminatum	0	0.00	0.00	0.000	0.000	0.000
Dichanthelium boscii	0	0.00	0.00	0.000	0.000	0.000
Dichanthelium clandestinum	0	0.00	0.00	0.000	0.000	0.000
Dichanthelium villosissimum	0	0.00	0.00	0.000	0.000	0.000
dicot 2 (Lobelia inflata?) seedling	0	0.00	0.00	0.000	0.000	0.000
dicot 3 seedling	0	0.00	0.00	0.000	0.000	0.000
Dioscorea villosa	0	0.00	0.00	0.000	0.000	0.000
Diospyros virginiana	1	1.39	0.32	0.007	0.010	0.327
Elaeagnus umbellata	0	0.00	0.00	0.000	0.000	0.000
Elymus hystrix	0	0.00	0.00	0.000	0.000	0.000
Elymus villosus	1	1.39	0.32	0.208	0.313	0.629
Elymus virginicus	0	0.00	0.00	0.000	0.000	0.000
Erechtites hieracifolia	0	0.00	0.00	0.000	0.000	0.000
Erigeron annuus	0	0.00	0.00	0.000	0.000	0.000
Euonymus atropurpureus	0	0.00	0.00	0.000	0.000	0.000
Eupatorium altissimum	0	0.00	0.00	0.000	0.000	0.000
Eupatorium purpureum	1	1.39	0.32	0.042	0.063	0.379
Eupatorium rugosum	24	33.33	7.59	3.194	4.793	12.388
Eupatorium serotinum	0	0.00	0.00	0.000	0.000	0.000
Festuca obtusa	5	6.94	1.58	0.472	0.709	2.291
Festuca pratensis	0	0.00	0.00	0.000	0.000	0.000
Fraxinus americana	1	1.39	0.32	0.208	0.313	0.629
Galium aparine	0	0.00	0.00	0.000	0.000	0.000
Galium circaezans	8	11.11	2.53	0.194	0.292	2.823
Galium concinnum	0	0.00	0.00	0.000	0.000	0.000
Galium triflorum	5	6.94	1.58	0.306	0.458	2.041
Geranium maculatum	0	0.00	0.00	0.000	0.000	0.000
Geum canadense	9	12.50	2.85	0.403	0.604	3.452
Gleditsia triacanthos	0	0.00	0.00	0.000	0.000	0.000
Hackelia virginica	0	0.00	0.00	0.000	0.000	0.000
Helianthus strumosus	0	0.00	0.00	0.000	0.000	0.000
Hydrophyllum virginianum	0	0.00	0.00	0.000	0.000	0.000
Impatiens capensis	12	16.67	3.80	1.097	1.646	5.444
Ipomoea sp.	0	0.00	0.00	0.000	0.000	0.000
Juniperus virginiana	0	0.00	0.00	0.000	0.000	0.000
Lactuca biennis	0	0.00	0.00	0.000	0.000	0.000
Lactuca canadensis	0	0.00	0.00	0.000	0.000	0.000

Baseline (2003) Ground Cover Data - Unit 12	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Leersia virginica	0	0.00	0.00	0.000	0.000	0.000
Lespedeza sp.	0	0.00	0.00	0.000	0.000	0.000
Lonicera maackii	0	0.00	0.00	0.000	0.000	0.000
Menispermum canadense	0	0.00	0.00	0.000	0.000	0.000
Monarda bradburiana	0	0.00	0.00	0.000	0.000	0.000
Morus alba	0	0.00	0.00	0.000	0.000	0.000
Morus rubra	0	0.00	0.00	0.000	0.000	0.000
Muhlenbergia schreberi	0	0.00	0.00	0.000	0.000	0.000
Muhlenbergia sobolifera	0	0.00	0.00	0.000	0.000	0.000
Osmorhiza longistylis	0	0.00	0.00	0.000	0.000	0.000
Oxalis dillenii/stricta	0	0.00	0.00	0.000	0.000	0.000
Oxalis fontana	2	2.78	0.63	0.014	0.021	0.654
Parietaria pensylvanica	1	1.39	0.32	0.007	0.010	0.327
Parthenocissus quinquefolia	67	93.06	21.20	34.236	51.370	72.573
Penstemon calycosa	0	0.00	0.00	0.000	0.000	0.000
Phlox divaricata	0	0.00	0.00	0.000	0.000	0.000
Phryma leptostachya	3	4.17	0.95	0.292	0.438	1.387
Physalis sp.	0	0.00	0.00	0.000	0.000	0.000
Phytolacca americana	0	0.00	0.00	0.000	0.000	0.000
Pilea pumila	9	12.50	2.85	0.167	0.250	3.098
Poa pratensis	0	0.00	0.00	0.000	0.000	0.000
Poa sylvestris	6	8.33	1.90	0.583	0.875	2.774
Poaceae (cf. Agrostis sp.)	0	0.00	0.00	0.000	0.000	0.000
Podophyllum peltatum	0	0.00	0.00	0.000	0.000	0.000
Polygonatum commutatum	0	0.00	0.00	0.000	0.000	0.000
Polygonum cristatum	0	0.00	0.00	0.000	0.000	0.000
Polygonum virginicum	9	12.50	2.85	0.569	0.854	3.703
Polygonum sp.	1	1.39	0.32	0.007	0.010	0.327
Prenanthes sp.	1	1.39	0.32	0.208	0.313	0.629
Prunus serotina	4	5.56	1.27	0.229	0.344	1.610
Ptelea trifoliata	0	0.00	0.00	0.000	0.000	0.000
Quercus alba	0	0.00	0.00	0.000	0.000	0.000
Quercus imbricaria	0	0.00	0.00	0.000	0.000	0.000
Quercus muhlenbergii	0	0.00	0.00	0.000	0.000	0.000
Quercus rubra	1	1.39	0.32	0.042	0.063	0.379
Quercus velutina	0	0.00	0.00	0.000	0.000	0.000
Ranunculus abortivus	0	0.00	0.00	0.000	0.000	0.000
Ranunculus septentrionalis	0	0.00	0.00	0.000	0.000	0.000
Rhus aromatica	0	0.00	0.00	0.000	0.000	0.000
Ribes missouriense	0	0.00	0.00	0.000	0.000	0.000
Rosa multiflora	1	1.39	0.32	0.007	0.010	0.327
Rubus allegheniensis	0	0.00	0.00	0.000	0.000	0.000
Rubus flagellaris	1	1.39	0.32	0.208	0.313	0.629
Rubus pensylvanicus	2	2.78	0.63	0.083	0.125	0.758
Sanicula canadensis	0	0.00	0.00	0.000	0.000	0.000
Sanicula odorata	17	23.61	5.38	6.819	10.232	15.612
Sassafras albicans	0	0.00	0.00	0.000	0.000	0.000
Scutellaria incana	0	0.00	0.00	0.000	0.000	0.000

Baseline (2003) Ground Cover Data - Unit 12	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Silene stellata	0	0.00	0.00	0.000	0.000	0.000
Smilacina racemosa	0	0.00	0.00	0.000	0.000	0.000
Smilax ecirrhata	0	0.00	0.00	0.000	0.000	0.000
Smilax hispida	0	0.00	0.00	0.000	0.000	0.000
Smilax lasioneuron	0	0.00	0.00	0.000	0.000	0.000
Solidago canadensis	0	0.00	0.00	0.000	0.000	0.000
Solidago ulmifolia	0	0.00	0.00	0.000	0.000	0.000
Specularia perfoliata	0	0.00	0.00	0.000	0.000	0.000
Staphylea trifolia	0	0.00	0.00	0.000	0.000	0.000
Symphoricarpos orbiculatus	3	4.17	0.95	0.771	1.157	2.106
Teucrium canadense	0	0.00	0.00	0.000	0.000	0.000
Toxicodendron radicans	5	6.94	1.58	0.708	1.063	2.645
Trillium recurvatum	0	0.00	0.00	0.000	0.000	0.000
Ulmus rubra	28	38.89	8.86	5.090	7.638	16.499
Vernonia sp.	0	0.00	0.00	0.000	0.000	0.000
Verbesina helianthoides	0	0.00	0.00	0.000	0.000	0.000
Veronicastrum virginicum	0	0.00	0.00	0.000	0.000	0.000
Viola pensylvanica pubescens	0	0.00	0.00	0.000	0.000	0.000
Viola pratincola	2	2.78	0.63	0.049	0.073	0.706
Viola sororia	10	13.89	3.16	0.444	0.667	3.831
Viola triloba	0	0.00	0.00	0.000	0.000	0.000
Vitis cinerea	0	0.00	0.00	0.000	0.000	0.000
Vitis riparia	6	8.33	1.90	0.111	0.167	2.065
Woodsia obtusa	0	0.00	0.00	0.000	0.000	0.000
Zanthoxylem americanum	0	0.00	0.00	0.000	0.000	0.000
			100.00		100.000	200.000

SUMMARY DATA

Total Species # (72 quadrats)	51
Percent Cover	66.65
Species Density	4.39

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 18	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Bare Ground				51.39		
Acalypha rhomboidea	0	0.00	0.00	0.00	0.00	0.00
Acalypha virginica	0	0.00	0.00	0.00	0.00	0.00
Acer saccharinum	0	0.00	0.00	0.00	0.00	0.00
Agastache nepetoides	0	0.00	0.00	0.00	0.00	0.00
Agrimonia pubescens	0	0.00	0.00	0.00	0.00	0.00
Agrimonia rostellata	1	2.78	0.64	0.01	0.18	0.82
Allium canadense	0	0.00	0.00	0.00	0.00	0.00
Amphicarpa bracteata	0	0.00	0.00	0.00	0.00	0.00
Aplectrum hyemale	0	0.00	0.00	0.00	0.00	0.00
Arisaema dracontium	0	0.00	0.00	0.00	0.00	0.00
Arisaema triphyllum	4	11.11	2.55	0.02	0.42	2.97
Aristolochia serpentaria	1	2.78	0.64	0.00	0.03	0.67
Asplenium platyneuron	0	0.00	0.00	0.00	0.00	0.00
Aster lateriflorus	0	0.00	0.00	0.00	0.00	0.00
Aster ontarionis	1	2.78	0.64	0.01	0.18	0.82
Aster pilosus	0	0.00	0.00	0.00	0.00	0.00
Aster simplex	0	0.00	0.00	0.00	0.00	0.00
Bidens cf. *frondosa*	0	0.00	0.00	0.00	0.00	0.00
Blephelia cf. *hirsuta*	0	0.00	0.00	0.00	0.00	0.00
Botrychium cf. *obliquum*	0	0.00	0.00	0.00	0.00	0.00
Botrychium virginicum	3	8.33	1.91	0.02	0.39	2.30
Bromus pubescens	0	0.00	0.00	0.00	0.00	0.00
Cacalia atriplicifolia	0	0.00	0.00	0.00	0.00	0.00
Calystegia sepium	0	0.00	0.00	0.00	0.00	0.00
Campanula americana	0	0.00	0.00	0.00	0.00	0.00
Campsis radicans	0	0.00	0.00	0.00	0.00	0.00
Cardamine parviflora	0	0.00	0.00	0.00	0.00	0.00
Carex albicans	0	0.00	0.00	0.00	0.00	0.00
Carex blanda	1	2.78	0.64	0.01	0.18	0.82
Carex cephalophora	0	0.00	0.00	0.00	0.00	0.00
Carex cf. grisea	0	0.00	0.00	0.00	0.00	0.00
Carex hirsutella	0	0.00	0.00	0.00	0.00	0.00
Carex hirtifolia	0	0.00	0.00	0.00	0.00	0.00
Carex jamesii	0	0.00	0.00	0.00	0.00	0.00
Carex laxiflora	0	0.00	0.00	0.00	0.00	0.00
Carex oligocarpa	0	0.00	0.00	0.00	0.00	0.00
Carex radiata	0	0.00	0.00	0.00	0.00	0.00
Carex sp. (glabrous, 3 mm)	0	0.00	0.00	0.00	0.00	0.00
Carex sp. (seedling)	0	0.00	0.00	0.00	0.00	0.00
Carya cordiformis	0	0.00	0.00	0.00	0.00	0.00
Carya ovata	0	0.00	0.00	0.00	0.00	0.00
Carya tomentosa	0	0.00	0.00	0.00	0.00	0.00
Celastris scandens	0	0.00	0.00	0.00	0.00	0.00
Celtis occidentalis	11	30.56	7.01	0.03	0.63	7.64
Cercis canadensis	2	5.56	1.27	0.01	0.21	1.48
Chenopodium album	0	0.00	0.00	0.00	0.00	0.00
Chenopodium standleyanum	0	0.00	0.00	0.00	0.00	0.00

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 18	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Cinna arundinacea	0	0.00	0.00	0.00	0.00	0.00
Circaea lutetiana	2	5.56	1.27	0.02	0.36	1.63
Conyza canadensis	0	0.00	0.00	0.00	0.00	0.00
Cornus drummondii	1	2.78	0.64	0.04	0.90	1.54
Cornus racemosa	0	0.00	0.00	0.00	0.00	0.00
Corylus americana	0	0.00	0.00	0.00	0.00	0.00
Cryptotaenia canadensis	0	0.00	0.00	0.00	0.00	0.00
Cystopteris protrusa	0	0.00	0.00	0.00	0.00	0.00
Desmodium glutinosum	2	5.56	1.27	0.04	0.93	2.20
Dichanthelium acuminatum	0	0.00	0.00	0.00	0.00	0.00
Dichanthelium boscii	0	0.00	0.00	0.00	0.00	0.00
Dichanthelium clandestinum	0	0.00	0.00	0.00	0.00	0.00
Dichanthelium villosissimum	0	0.00	0.00	0.00	0.00	0.00
dicot 2 (Lobelia inflata?) seedling	0	0.00	0.00	0.00	0.00	0.00
dicot 3 seedling	3	8.33	1.91	0.00	0.09	2.00
Dioscorea villosa	0	0.00	0.00	0.00	0.00	0.00
Diospyros virginiana	1	2.78	0.64	0.01	0.18	0.82
Elaeagnus umbellata	0	0.00	0.00	0.00	0.00	0.00
Elymus hystrix	0	0.00	0.00	0.00	0.00	0.00
Elymus villosus	0	0.00	0.00	0.00	0.00	0.00
Elymus virginicus	0	0.00	0.00	0.00	0.00	0.00
Erechtites hieracifolia	0	0.00	0.00	0.00	0.00	0.00
Erigeron annuus	0	0.00	0.00	0.00	0.00	0.00
Euonymus atropurpureus	1	2.78	0.64	0.01	0.18	0.82
Eupatorium altissimum	0	0.00	0.00	0.00	0.00	0.00
Eupatorium purpureum	0	0.00	0.00	0.00	0.00	0.00
Eupatorium rugosum	10	27.78	6.37	0.15	3.50	9.87
Eupatorium serotinum	0	0.00	0.00	0.00	0.00	0.00
Festuca obtusa	0	0.00	0.00	0.00	0.00	0.00
Festuca pratensis	0	0.00	0.00	0.00	0.00	0.00
Fraxinus americana	1	2.78	0.64	0.00	0.03	0.67
Galium aparine	0	0.00	0.00	0.00	0.00	0.00
Galium circaezans	0	0.00	0.00	0.00	0.00	0.00
Galium concinnum	0	0.00	0.00	0.00	0.00	0.00
Galium triflorum	0	0.00	0.00	0.00	0.00	0.00
Geranium maculatum	0	0.00	0.00	0.00	0.00	0.00
Geum canadense	3	8.33	1.91	0.00	0.09	2.00
Gleditsia triacanthos	0	0.00	0.00	0.00	0.00	0.00
Hackelia virginica	0	0.00	0.00	0.00	0.00	0.00
Helianthus strumosus	0	0.00	0.00	0.00	0.00	0.00
Hydrophyllum virginianum	0	0.00	0.00	0.00	0.00	0.00
Impatiens capensis	0	0.00	0.00	0.00	0.00	0.00
Ipomoea sp.	0	0.00	0.00	0.00	0.00	0.00
Juniperus virginiana	0	0.00	0.00	0.00	0.00	0.00
Lactuca biennis	0	0.00	0.00	0.00	0.00	0.00
Lactuca canadensis	0	0.00	0.00	0.00	0.00	0.00
Leersia virginica	0	0.00	0.00	0.00	0.00	0.00
Lespedeza sp.	0	0.00	0.00	0.00	0.00	0.00

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 18	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Lonicera maackii	0	0.00	0.00	0.00	0.00	0.00
Menispermum canadense	1	2.78	0.64	0.04	0.90	1.54
Monarda bradburiana	0	0.00	0.00	0.00	0.00	0.00
Morus alba	0	0.00	0.00	0.00	0.00	0.00
Morus rubra	0	0.00	0.00	0.00	0.00	0.00
Muhlenbergia schreberi	0	0.00	0.00	0.00	0.00	0.00
Muhlenbergia sobolifera	0	0.00	0.00	0.00	0.00	0.00
Osmorhiza longistylis	0	0.00	0.00	0.00	0.00	0.00
Oxalis dillenii/stricta	0	0.00	0.00	0.00	0.00	0.00
Oxalis fontana	0	0.00	0.00	0.00	0.00	0.00
Parietaria pensylvanica	0	0.00	0.00	0.00	0.00	0.00
Parthenocissus quinquefolia	24	66.67	15.29	1.68	40.19	55.48
Penstemon calycosa	0	0.00	0.00	0.00	0.00	0.00
Phlox divaricata	0	0.00	0.00	0.00	0.00	0.00
Phryma leptostachya	3	8.33	1.91	0.00	0.09	2.00
Physalis sp.	0	0.00	0.00	0.00	0.00	0.00
Phytolacca americana	0	0.00	0.00	0.00	0.00	0.00
Pilea pumila	2	5.56	1.27	0.00	0.06	1.33
Poa pratensis	0	0.00	0.00	0.00	0.00	0.00
Poa sylvestris	0	0.00	0.00	0.00	0.00	0.00
Poaceae (cf. Agrostis sp.)	0	0.00	0.00	0.00	0.00	0.00
Podophyllum peltatum	0	0.00	0.00	0.00	0.00	0.00
Polygonatum commutatum	2	5.56	1.27	0.01	0.21	1.48
Polygonum cristatum	0	0.00	0.00	0.00	0.00	0.00
Polygonum virginicum	6	16.67	3.82	0.05	1.20	5.02
Polygonum sp.	0	0.00	0.00	0.00	0.00	0.00
Prenanthes sp.	0	0.00	0.00	0.00	0.00	0.00
Prunus serotina	2	5.56	1.27	0.00	0.06	1.33
Ptelea trifoliata	0	0.00	0.00	0.00	0.00	0.00
Quercus alba	1	2.78	0.64	0.01	0.18	0.82
Quercus imbricaria	0	0.00	0.00	0.00	0.00	0.00
Quercus muhlenbergii	0	0.00	0.00	0.00	0.00	0.00
Quercus rubra	1	2.78	0.64	0.01	0.18	0.82
Quercus velutina	2	5.56	1.27	0.01	0.21	1.48
Ranunculus abortivus	0	0.00	0.00	0.00	0.00	0.00
Ranunculus septentrionalis	0	0.00	0.00	0.00	0.00	0.00
Rhus aromatica	0	0.00	0.00	0.00	0.00	0.00
Ribes missouriense	6	16.67	3.82	0.14	3.23	7.06
Rosa multiflora	1	2.78	0.64	0.04	0.90	1.54
Rubus allegheniensis	0	0.00	0.00	0.00	0.00	0.00
Rubus flagellaris	2	5.56	1.27	0.01	0.21	1.48
Rubus pensylvanicus	2	5.56	1.27	0.01	0.21	1.48
Sanicula canadensis	0	0.00	0.00	0.00	0.00	0.00
Sanicula odorata	15	41.67	9.55	0.65	15.66	25.22
Sassafras albicans	0	0.00	0.00	0.00	0.00	0.00
Scutellaria incana	0	0.00	0.00	0.00	0.00	0.00
Silene stellata	0	0.00	0.00	0.00	0.00	0.00
Smilacina racemosa	3	8.33	1.91	0.05	1.26	3.17

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 18	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Smilax ecirrhata	0	0.00	0.00	0.00	0.00	0.00
Smilax hispida	5	13.89	3.18	0.07	1.62	4.80
Smilax lasioneuron	0	0.00	0.00	0.00	0.00	0.00
Solidago canadensis	0	0.00	0.00	0.00	0.00	0.00
Solidago ulmifolia	0	0.00	0.00	0.00	0.00	0.00
Specularia perfoliata	0	0.00	0.00	0.00	0.00	0.00
Staphylea trifolia	0	0.00	0.00	0.00	0.00	0.00
Symphoricarpos orbiculatus	0	0.00	0.00	0.00	0.00	0.00
Teucrium canadense	0	0.00	0.00	0.00	0.00	0.00
Toxicodendron radicans	0	0.00	0.00	0.00	0.00	0.00
Trillium recurvatum	1	2.78	0.64	0.00	0.03	0.67
Ulmus rubra	18	50.00	11.46	1.02	24.47	35.93
Vernonia sp.	0	0.00	0.00	0.00	0.00	0.00
Verbesina helianthoides	0	0.00	0.00	0.00	0.00	0.00
Veronicastrum virginicum	0	0.00	0.00	0.00	0.00	0.00
Viola pensylvanica pubescens	0	0.00	0.00	0.00	0.00	0.00
Viola pratincola	2	5.56	1.27	0.00	0.06	1.33
Viola sororia	3	8.33	1.91	0.01	0.24	2.15
Viola triloba	0	0.00	0.00	0.00	0.00	0.00
Vitis cinerea	0	0.00	0.00	0.00	0.00	0.00
Vitis riparia	7	19.44	4.46	0.02	0.36	4.82
Woodsia obtusa	0	0.00	0.00	0.00	0.00	0.00
Zanthoxylem americanum	0	0.00	0.00	0.00	0.00	0.00
			100.00		100.00	200.00

SUMMARY DATA

Total Species # (36 quadrats)	39
Percent Cover	46.38
Species Density	4.36

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 4	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Bare Ground				17.67		
Acalypha rhomboidea	10.00	27.78	2.46	0.49	0.42	2.88
Acalypha virginica	2.00	5.56	0.49	0.10	0.08	0.58
Acer saccharinum	0.00	0.00	0.00	0.00	0.00	0.00
Agastache nepetoides	0.00	0.00	0.00	0.00	0.00	0.00
Agrimonia pubescens	6.00	16.67	1.48	1.17	1.00	2.47
Agrimonia rostellata	0.00	0.00	0.00	0.00	0.00	0.00
Allium canadense	0.00	0.00	0.00	0.00	0.00	0.00
Amphicarpa bracteata	3.00	8.33	0.74	1.21	1.03	1.77
Aplectrum hyemale	0.00	0.00	0.00	0.00	0.00	0.00
Arisaema dracontium	0.00	0.00	0.00	0.00	0.00	0.00
Arisaema triphyllum	3.00	8.33	0.74	0.18	0.15	0.89
Aristolochia serpentaria	2.00	5.56	0.49	0.03	0.02	0.52
Asplenium platyneuron	0.00	0.00	0.00	0.00	0.00	0.00
Aster lateriflorus	0.00	0.00	0.00	0.00	0.00	0.00
Aster ontarionis	0.00	0.00	0.00	0.00	0.00	0.00
Aster pilosus	0.00	0.00	0.00	0.00	0.00	0.00
Aster simplex	0.00	0.00	0.00	0.00	0.00	0.00
Bidens cf. *frondosa*	0.00	0.00	0.00	0.00	0.00	0.00
Blephelia cf. *hirsuta*	0.00	0.00	0.00	0.00	0.00	0.00
Botrychium cf. *obliquum*	0.00	0.00	0.00	0.00	0.00	0.00
Botrychium virginicum	3.00	8.33	0.74	0.04	0.04	0.77
Bromus pubescens	15.00	41.67	3.69	3.89	3.32	7.02
Cacalia atriplicifolia	0.00	0.00	0.00	0.00	0.00	0.00
Calystegia sepium	4.00	11.11	0.99	0.60	0.51	1.50
Campanula americana	0.00	0.00	0.00	0.00	0.00	0.00
Campsis radicans	2.00	5.56	0.49	0.50	0.43	0.92
Cardamine parviflora	0.00	0.00	0.00	0.00	0.00	0.00
Carex albicans	9.00	25.00	2.22	6.14	5.24	7.46
Carex blanda	1.00	2.78	0.25	0.01	0.01	0.26
Carex cephalophora	7.00	19.44	1.72	0.44	0.38	2.10
Carex cf. grisea	1.00	2.78	0.25	0.08	0.07	0.32
Carex hirsutella	1.00	2.78	0.25	0.42	0.36	0.60
Carex hirtifolia	0.00	0.00	0.00	0.00	0.00	0.00
Carex jamesii	0.00	0.00	0.00	0.00	0.00	0.00
Carex laxiflora	0.00	0.00	0.00	0.00	0.00	0.00
Carex oligocarpa	0.00	0.00	0.00	0.00	0.00	0.00
Carex radiata	0.00	0.00	0.00	0.00	0.00	0.00
Carex sp. (glabrous, 3 mm)	0.00	0.00	0.00	0.00	0.00	0.00
Carex sp. (seedling)	2.00	5.56	0.49	0.43	0.37	0.86
Carya cordiformis	0.00	0.00	0.00	0.00	0.00	0.00
Carya ovata	1.00	2.78	0.25	0.01	0.01	0.26
Carya tomentosa	0.00	0.00	0.00	0.00	0.00	0.00
Celastris scandens	4.00	11.11	0.99	0.67	0.57	1.55
Celtis occidentalis	6.00	16.67	1.48	0.29	0.25	1.73
Cercis canadensis	10.00	27.78	2.46	1.56	1.33	3.79
Chenopodium album	0.00	0.00	0.00	0.00	0.00	0.00
Chenopodium standleyanum	9.00	25.00	2.22	1.61	1.38	3.59

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 4	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Cinna arundinacea	0.00	0.00	0.00	0.00	0.00	0.00
Circaea lutetiana	3.00	8.33	0.74	1.14	0.97	1.71
Conyza canadensis	3.00	8.33	0.74	0.04	0.04	0.77
Cornus drummondii	0.00	0.00	0.00	0.00	0.00	0.00
Cornus racemosa	0.00	0.00	0.00	0.00	0.00	0.00
Corylus americana	0.00	0.00	0.00	0.00	0.00	0.00
Cryptotaenia canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Cystopteris protrusa	0.00	0.00	0.00	0.00	0.00	0.00
Desmodium glutinosum	0.00	0.00	0.00	0.00	0.00	0.00
Dichanthelium acuminatum	2.00	5.56	0.49	0.03	0.02	0.52
Dichanthelium boscii	0.00	0.00	0.00	0.00	0.00	0.00
Dichanthelium clandestinum	0.00	0.00	0.00	0.00	0.00	0.00
Dichanthelium villosissimum	1.00	2.78	0.25	0.01	0.01	0.26
dicot 2 (Lobelia inflata?) seedling	0.00	0.00	0.00	0.00	0.00	0.00
dicot 3 seedling	2.00	5.56	0.49	0.03	0.02	0.52
Dioscorea villosa	2.00	5.56	0.49	0.50	0.43	0.92
Diospyros virginiana	0.00	0.00	0.00	0.00	0.00	0.00
Elaeagnus umbellata	0.00	0.00	0.00	0.00	0.00	0.00
Elymus hystrix	9.00	25.00	2.22	2.86	2.44	4.66
Elymus villosus	8.00	22.22	1.97	2.96	2.53	4.50
Elymus virginicus	2.00	5.56	0.49	0.50	0.43	0.92
Erechtites hieracifolia	0.00	0.00	0.00	0.00	0.00	0.00
Erigeron annuus	2.00	5.56	0.49	0.03	0.02	0.52
Euonymus atropurpureus	2.00	5.56	0.49	0.43	0.37	0.86
Eupatorium altissimum	0.00	0.00	0.00	0.00	0.00	0.00
Eupatorium purpureum	1.00	2.78	0.25	0.42	0.36	0.60
Eupatorium rugosum	28.00	77.78	6.90	4.33	3.70	10.60
Eupatorium serotinum	2.00	5.56	0.49	0.50	0.43	0.92
Festuca obtusa	0.00	0.00	0.00	0.00	0.00	0.00
Festuca pratensis	0.00	0.00	0.00	0.00	0.00	0.00
Fraxinus americana	0.00	0.00	0.00	0.00	0.00	0.00
Galium aparine	0.00	0.00	0.00	0.00	0.00	0.00
Galium circaezans	19.00	52.78	4.68	1.36	1.16	5.84
Galium concinnum	0.00	0.00	0.00	0.00	0.00	0.00
Galium triflorum	0.00	0.00	0.00	0.00	0.00	0.00
Geranium maculatum	0.00	0.00	0.00	0.00	0.00	0.00
Geum canadense	5.00	13.89	1.23	0.07	0.06	1.29
Gleditsia triacanthos	0.00	0.00	0.00	0.00	0.00	0.00
Hackelia virginica	3.00	8.33	0.74	0.11	0.09	0.83
Helianthus strumosus	26.00	72.22	6.40	25.88	22.10	28.50
Hydrophyllum virginianum	0.00	0.00	0.00	0.00	0.00	0.00
Impatiens capensis	0.00	0.00	0.00	0.00	0.00	0.00
Ipomoea sp.	0.00	0.00	0.00	0.00	0.00	0.00
Juniperus virginiana	0.00	0.00	0.00	0.00	0.00	0.00
Lactuca biennis	1.00	2.78	0.25	0.01	0.01	0.26
Lactuca canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Leersia virginica	0.00	0.00	0.00	0.00	0.00	0.00
Lespedeza sp.	1.00	2.78	0.25	0.01	0.01	0.26

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 4	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Lonicera maackii	0.00	0.00	0.00	0.00	0.00	0.00
Menispermum canadense	0.00	0.00	0.00	0.00	0.00	0.00
Monarda bradburiana	0.00	0.00	0.00	0.00	0.00	0.00
Morus alba	0.00	0.00	0.00	0.00	0.00	0.00
Morus rubra	0.00	0.00	0.00	0.00	0.00	0.00
Muhlenbergia schreberi	0.00	0.00	0.00	0.00	0.00	0.00
Muhlenbergia sobolifera	4.00	11.11	0.99	1.99	1.70	2.68
Osmorhiza longistylis	0.00	0.00	0.00	0.00	0.00	0.00
Oxalis dillenii/stricta	1.00	2.78	0.25	0.01	0.01	0.26
Oxalis fontana	0.00	0.00	0.00	0.00	0.00	0.00
Parietaria pensylvanica	4.00	11.11	0.99	0.26	0.23	1.21
Parthenocissus quinquefolia	21.00	58.33	5.17	7.42	6.33	11.51
Penstemon calycosa	0.00	0.00	0.00	0.00	0.00	0.00
Phlox divaricata	3.00	8.33	0.74	0.11	0.09	0.83
Phryma leptostachya	11.00	30.56	2.71	2.33	1.99	4.70
Physalis sp.	0.00	0.00	0.00	0.00	0.00	0.00
Phytolacca americana	8.00	22.22	1.97	0.79	0.68	2.65
Pilea pumila	0.00	0.00	0.00	0.00	0.00	0.00
Poa pratensis	0.00	0.00	0.00	0.00	0.00	0.00
Poa sylvestris	0.00	0.00	0.00	0.00	0.00	0.00
Poaceae (cf. Agrostis sp.)	0.00	0.00	0.00	0.00	0.00	0.00
Podophyllum peltatum	0.00	0.00	0.00	0.00	0.00	0.00
Polygonatum commutatum	2.00	5.56	0.49	0.10	0.08	0.58
Polygonum cristatum	0.00	0.00	0.00	0.00	0.00	0.00
Polygonum virginicum	3.00	8.33	0.74	1.54	1.32	2.06
Polygonum sp.	0.00	0.00	0.00	0.00	0.00	0.00
Prenanthes sp.	0.00	0.00	0.00	0.00	0.00	0.00
Prunus serotina	1.00	2.78	0.25	0.08	0.07	0.32
Ptelea trifoliata	0.00	0.00	0.00	0.00	0.00	0.00
Quercus alba	1.00	2.78	0.25	0.08	0.07	0.32
Quercus imbricaria	1.00	2.78	0.25	0.01	0.01	0.26
Quercus muhlenbergii	0.00	0.00	0.00	0.00	0.00	0.00
Quercus rubra	0.00	0.00	0.00	0.00	0.00	0.00
Quercus velutina	1.00	2.78	0.25	0.08	0.07	0.32
Ranunculus abortivus	0.00	0.00	0.00	0.00	0.00	0.00
Ranunculus septentrionalis	0.00	0.00	0.00	0.00	0.00	0.00
Rhus aromatica	4.00	11.11	0.99	1.00	0.85	1.84
Ribes missouriense	0.00	0.00	0.00	0.00	0.00	0.00
Rosa multiflora	0.00	0.00	0.00	0.00	0.00	0.00
Rubus allegheniensis	6.00	16.67	1.48	0.89	0.76	2.24
Rubus flagellaris	0.00	0.00	0.00	0.00	0.00	0.00
Rubus pensylvanicus	0.00	0.00	0.00	0.00	0.00	0.00
Sanicula canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Sanicula odorata	25.00	69.44	6.16	19.10	16.31	22.47
Sassafras albicans	4.00	11.11	0.99	0.93	0.79	1.78
Scutellaria incana	2.00	5.56	0.49	0.83	0.71	1.20
Silene stellata	8.00	22.22	1.97	3.58	3.06	5.03
Smilacina racemosa	3.00	8.33	0.74	0.92	0.78	1.52

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 4	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Smilax ecirrhata	0.00	0.00	0.00	0.00	0.00	0.00
Smilax hispida	2.00	5.56	0.49	0.17	0.14	0.63
Smilax lasioneuron	3.00	8.33	0.74	0.18	0.15	0.89
Solidago canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Solidago ulmifolia	12.00	33.33	2.96	5.10	4.35	7.31
Specularia perfoliata	8.00	22.22	1.97	0.79	0.68	2.65
Staphylea trifolia	0.00	0.00	0.00	0.00	0.00	0.00
Symphoricarpos orbiculatus	0.00	0.00	0.00	0.00	0.00	0.00
Teucrium canadense	0.00	0.00	0.00	0.00	0.00	0.00
Toxicodendron radicans	1.00	2.78	0.25	1.04	0.89	1.14
Trillium recurvatum	1.00	2.78	0.25	0.08	0.07	0.32
Ulmus rubra	12.00	33.33	2.96	4.51	3.86	6.81
Vernonia sp.	0.00	0.00	0.00	0.00	0.00	0.00
Verbesina helianthoides	2.00	5.56	0.49	0.10	0.08	0.58
Veronicastrum virginicum	0.00	0.00	0.00	0.00	0.00	0.00
Viola pensylvanica pubescens	0.00	0.00	0.00	0.00	0.00	0.00
Viola pratincola	0.00	0.00	0.00	0.00	0.00	0.00
Viola sororia	16.00	44.44	3.94	0.69	0.59	4.53
Viola triloba	0.00	0.00	0.00	0.00	0.00	0.00
Vitis cinerea	2.00	5.56	0.49	0.83	0.71	1.20
Vitis riparia	9.00	25.00	2.22	0.33	0.28	2.50
Woodsia obtusa	0.00	0.00	0.00	0.00	0.00	0.00
Zanthoxylem americanum	2.00	5.56	0.49	0.10	0.08	0.58
			100.00		100.00	200.00

SUMMARY DATA

Total Species # (36 quadrats)	73
Percent Cover	117.08
Species Density/0.25-m^2	11.28

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 5	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Bare Ground				34.1		
Acalypha rhomboidea	0.00	0.00	0.00	0.00	0.00	0.00
Acalypha virginica	0.00	0.00	0.00	0.00	0.00	0.00
Acer saccharinum	0.00	0.00	0.00	0.00	0.00	0.00
Agastache nepetoides	2.00	2.78	0.36	0.08	0.24	0.60
Agrimonia pubescens	0.00	0.00	0.00	0.00	0.00	0.00
Agrimonia rostellata	3.00	4.17	0.54	0.04	0.12	0.66
Allium canadense	0.00	0.00	0.00	0.00	0.00	0.00
Amphicarpa bracteata	3.00	4.17	0.54	0.06	0.16	0.70
Aplectrum hyemale	0.00	0.00	0.00	0.00	0.00	0.00
Arisaema dracontium	0.00	0.00	0.00	0.00	0.00	0.00
Arisaema triphyllum	2.00	2.78	0.36	0.04	0.12	0.48
Aristolochia serpentaria	2.00	2.78	0.36	0.00	0.00	0.36
Asplenium platyneuron	0.00	0.00	0.00	0.00	0.00	0.00
Aster lateriflorus	0.00	0.00	0.00	0.00	0.00	0.00
Aster ontarionis	1.00	1.39	0.18	0.00	0.00	0.18
Aster pilosus	0.00	0.00	0.00	0.00	0.00	0.00
Aster simplex	0.00	0.00	0.00	0.00	0.00	0.00
Bidens cf. *frondosa*	10.00	13.89	1.81	0.13	0.39	2.19
Blephelia cf. *hirsuta*	0.00	0.00	0.00	0.00	0.00	0.00
Botrychium cf. *obliquum*	0.00	0.00	0.00	0.00	0.00	0.00
Botrychium virginicum	6.00	8.33	1.08	0.05	0.14	1.23
Bromus pubescens	6.00	8.33	1.08	0.58	1.71	2.79
Cacalia atriplicifolia	1.00	1.39	0.18	0.01	0.02	0.20
Calystegia sepium	0.00	0.00	0.00	0.00	0.00	0.00
Campanula americana	3.00	4.17	0.54	0.94	2.74	3.28
Campsis radicans	0.00	0.00	0.00	0.00	0.00	0.00
Cardamine parviflora	0.00	0.00	0.00	0.00	0.00	0.00
Carex albicans	1.00	1.39	0.18	0.04	0.12	0.30
Carex blanda	3.00	4.17	0.54	0.21	0.61	1.15
Carex cephalophora	4.00	5.56	0.72	0.99	2.90	3.63
Carex cf. grisea	2.00	2.78	0.36	0.00	0.00	0.36
Carex hirsutella	0.00	0.00	0.00	0.00	0.00	0.00
Carex hirtifolia	1.00	1.39	0.18	0.00	0.00	0.18
Carex jamesii	0.00	0.00	0.00	0.00	0.00	0.00
Carex laxiflora	6.00	8.33	1.08	0.42	1.22	2.30
Carex oligocarpa	1.00	1.39	0.18	0.04	0.12	0.30
Carex radiata	1.00	1.39	0.18	0.00	0.00	0.18
Carex sp. (glabrous, 3 mm)	4.00	5.56	0.72	0.17	0.49	1.21
Carex sp. (seedling)	2.00	2.78	0.36	0.00	0.00	0.36
Carya cordiformis	1.00	1.39	0.18	0.00	0.00	0.18
Carya ovata	2.00	2.78	0.36	0.04	0.12	0.48
Carya tomentosa	0.00	0.00	0.00	0.00	0.00	0.00
Celastris scandens	4.00	5.56	0.72	0.00	0.00	0.72
Celtis occidentalis	5.00	6.94	0.90	0.08	0.24	1.15
Cercis canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Chenopodium album	0.00	0.00	0.00	0.00	0.00	0.00
Chenopodium standleyanum	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 5	occurrences (72 plots)	% freq-uency	rel. freq.	% Cover	Rel. Cover	IV200
Cinna arundinacea	10.00	13.89	1.81	0.00	0.00	1.81
Circaea lutetiana	33.00	45.83	5.96	2.37	6.93	12.88
Conyza canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Cornus drummondii	0.00	0.00	0.00	0.00	0.00	0.00
Cornus racemosa	5.00	6.94	0.90	0.29	0.85	1.76
Corylus americana	0.00	0.00	0.00	0.00	0.00	0.00
Cryptotaenia canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Cystopteris protrusa	0.00	0.00	0.00	0.00	0.00	0.00
Desmodium glutinosum	3.00	4.17	0.54	0.00	0.00	0.54
Dichanthelium acuminatum	0.00	0.00	0.00	0.00	0.00	0.00
Dichanthelium boscii	2.00	2.78	0.36	0.00	0.00	0.36
Dichanthelium clandestinum	1.00	1.39	0.18	0.01	0.02	0.20
Dichanthelium villosissimum	0.00	0.00	0.00	0.00	0.00	0.00
dicot 2 (Lobelia inflata?) seedling	0.00	0.00	0.00	0.00	0.00	0.00
dicot 3 seedling	0.00	0.00	0.00	0.00	0.00	0.00
Dioscorea villosa	0.00	0.00	0.00	0.00	0.00	0.00
Diospyros virginiana	0.00	0.00	0.00	0.00	0.00	0.00
Elaeagnus umbellata	0.00	0.00	0.00	0.00	0.00	0.00
Elymus hystrix	4.00	5.56	0.72	0.30	0.87	1.60
Elymus villosus	2.00	2.78	0.36	0.73	2.13	2.49
Elymus virginicus	0.00	0.00	0.00	0.00	0.00	0.00
Erechtites hieracifolia	0.00	0.00	0.00	0.00	0.00	0.00
Erigeron annuus	0.00	0.00	0.00	0.00	0.00	0.00
Euonymus atropurpureus	2.00	2.78	0.36	0.08	0.24	0.60
Eupatorium altissimum	0.00	0.00	0.00	0.00	0.00	0.00
Eupatorium purpureum	0.00	0.00	0.00	0.00	0.00	0.00
Eupatorium rugosum	50.00	69.44	9.03	3.44	10.08	19.10
Eupatorium serotinum	0.00	0.00	0.00	0.00	0.00	0.00
Festuca obtusa	9.00	12.50	1.62	0.21	0.61	2.23
Festuca pratensis	0.00	0.00	0.00	0.00	0.00	0.00
Fraxinus americana	1.00	1.39	0.18	0.00	0.00	0.18
Galium aparine	0.00	0.00	0.00	0.00	0.00	0.00
Galium circaezans	4.00	5.56	0.72	0.04	0.12	0.84
Galium concinnum	9.00	12.50	1.62	0.38	1.12	2.74
Galium triflorum	3.00	4.17	0.54	0.01	0.02	0.56
Geranium maculatum	0.00	0.00	0.00	0.00	0.00	0.00
Geum canadense	38.00	52.78	6.86	0.58	1.71	8.57
Gleditsia triacanthos	0.00	0.00	0.00	0.00	0.00	0.00
Hackelia virginica	9.00	12.50	1.62	0.06	0.18	1.81
Helianthus strumosus	2.00	2.78	0.36	0.56	1.65	2.01
Hydrophyllum virginianum	0.00	0.00	0.00	0.00	0.00	0.00
Impatiens capensis	0.00	0.00	0.00	0.00	0.00	0.00
Ipomoea sp.	0.00	0.00	0.00	0.00	0.00	0.00
Juniperus virginiana	0.00	0.00	0.00	0.00	0.00	0.00
Lactuca biennis	0.00	0.00	0.00	0.00	0.00	0.00
Lactuca canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Leersia virginica	4.00	5.56	0.72	0.58	1.69	2.41
Lespedeza sp.	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 5	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Lonicera maackii	0.00	0.00	0.00	0.00	0.00	0.00
Menispermum canadense	0.00	0.00	0.00	0.00	0.00	0.00
Monarda bradburiana	2.00	2.78	0.36	0.25	0.73	1.09
Morus alba	1.00	1.39	0.18	0.00	0.00	0.18
Morus rubra	0.00	0.00	0.00	0.00	0.00	0.00
Muhlenbergia schreberi	0.00	0.00	0.00	0.00	0.00	0.00
Muhlenbergia sobolifera	3.00	4.17	0.54	0.94	2.74	3.28
Osmorhiza longistylis	1.00	1.39	0.18	0.04	0.12	0.30
Oxalis dillenii/stricta	1.00	1.39	0.18	0.04	0.12	0.30
Oxalis fontana	0.00	0.00	0.00	0.00	0.00	0.00
Parietaria pensylvanica	6.00	8.33	1.08	0.04	0.12	1.20
Parthenocissus quinquefolia	33.00	45.83	5.96	1.02	2.99	8.94
Penstemon calycosa	0.00	0.00	0.00	0.00	0.00	0.00
Phlox divaricata	1.00	1.39	0.18	0.01	0.02	0.20
Phryma leptostachya	11.00	15.28	1.99	0.55	1.60	3.59
Physalis sp.	0.00	0.00	0.00	0.00	0.00	0.00
Phytolacca americana	1.00	1.39	0.18	0.21	0.61	0.79
Pilea pumila	27.00	37.50	4.87	0.52	1.52	6.40
Poa pratensis	0.00	0.00	0.00	0.00	0.00	0.00
Poa sylvestris	0.00	0.00	0.00	0.00	0.00	0.00
Poaceae (cf. Agrostis sp.)	0.00	0.00	0.00	0.00	0.00	0.00
Podophyllum peltatum	3.00	4.17	0.54	0.00	0.00	0.54
Polygonatum commutatum	0.00	0.00	0.00	0.00	0.00	0.00
Polygonum cristatum	0.00	0.00	0.00	0.00	0.00	0.00
Polygonum virginicum	28.00	38.89	5.05	0.29	0.85	5.91
Polygonum sp.	0.00	0.00	0.00	0.00	0.00	0.00
Prenanthes sp.	0.00	0.00	0.00	0.00	0.00	0.00
Prunus serotina	1.00	1.39	0.18	0.01	0.02	0.20
Ptelea trifoliata	1.00	1.39	0.18	0.00	0.00	0.18
Quercus alba	1.00	1.39	0.18	0.04	0.12	0.30
Quercus imbricaria	0.00	0.00	0.00	0.00	0.00	0.00
Quercus muhlenbergii	0.00	0.00	0.00	0.00	0.00	0.00
Quercus rubra	3.00	4.17	0.54	0.09	0.26	0.81
Quercus velutina	1.00	1.39	0.18	0.00	0.00	0.18
Ranunculus abortivus	0.00	0.00	0.00	0.00	0.00	0.00
Ranunculus septentrionalis	0.00	0.00	0.00	0.00	0.00	0.00
Rhus aromatica	0.00	0.00	0.00	0.00	0.00	0.00
Ribes missouriense	0.00	0.00	0.00	0.00	0.00	0.00
Rosa multiflora	4.00	5.56	0.72	0.46	1.34	2.06
Rubus allegheniensis	0.00	0.00	0.00	0.00	0.00	0.00
Rubus flagellaris	1.00	1.39	0.18	0.04	0.12	0.30
Rubus pensylvanicus	13.00	18.06	2.35	0.58	1.71	4.05
Sanicula canadensis	2.00	2.78	0.36	1.74	5.08	5.44
Sanicula odorata	64.00	88.89	11.55	6.24	18.24	29.79
Sassafras albicans	4.00	5.56	0.72	0.52	1.52	2.25
Scutellaria incana	0.00	0.00	0.00	0.00	0.00	0.00
Silene stellata	0.00	0.00	0.00	0.00	0.00	0.00
Smilacina racemosa	2.00	2.78	0.36	0.00	0.00	0.36

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 5	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Smilax ecirrhata	0.00	0.00	0.00	0.00	0.00	0.00
Smilax hispida	1.00	1.39	0.18	0.00	0.00	0.18
Smilax lasioneuron	2.00	2.78	0.36	0.21	0.61	0.97
Solidago canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Solidago ulmifolia	10.00	13.89	1.81	0.94	2.76	4.57
Specularia perfoliata	0.00	0.00	0.00	0.00	0.00	0.00
Staphylea trifolia	1.00	1.39	0.18	0.21	0.61	0.79
Symphoricarpos orbiculatus	0.00	0.00	0.00	0.00	0.00	0.00
Teucrium canadense	3.00	4.17	0.54	0.26	0.75	1.29
Toxicodendron radicans	10.00	13.89	1.81	1.83	5.36	7.17
Trillium recurvatum	1.00	1.39	0.18	0.21	0.61	0.79
Ulmus rubra	20.00	27.78	3.61	2.56	7.48	11.09
Vernonia sp.	0.00	0.00	0.00	0.00	0.00	0.00
Verbesina helianthoides	0.00	0.00	0.00	0.00	0.00	0.00
Veronicastrum virginicum	1.00	1.39	0.18	0.00	0.00	0.18
Viola pensylvanica pubescens	0.00	0.00	0.00	0.00	0.00	0.00
Viola pratincola	2.00	2.78	0.36	0.04	0.12	0.48
Viola sororia	11.00	15.28	1.99	0.40	1.18	3.16
Viola triloba	4.00	5.56	0.72	0.10	0.28	1.01
Vitis cinerea	0.00	0.00	0.00	0.00	0.00	0.00
Vitis riparia	6.00	8.33	1.08	0.24	0.69	1.77
Woodsia obtusa	0.00	0.00	0.00	0.00	0.00	0.00
Zanthoxylem americanum	0.00	0.00	0.00	0.00	0.00	0.00
			100.00		100.00	200.00

SUMMARY DATA

Total Species # (72 quadrats)	82
Percent Cover	75.86
Species Density/0.25-m^2	7.69

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 7	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Bare Ground				44.58		
Acalypha rhomboidea	0.00	0.00	0.00	0.00	0.00	0.00
Acalypha virginica	0.00	0.00	0.00	0.00	0.00	0.00
Acer saccharinum	0.00	0.00	0.00	0.00	0.00	0.00
Agastache nepetoides	0.00	0.00	0.00	0.00	0.00	0.00
Agrimonia pubescens	1.00	1.39	0.21	0.01	0.02	0.22
Agrimonia rostellata	5.00	6.94	1.04	0.38	0.86	1.90
Allium canadense	1.00	1.39	0.21	0.01	0.02	0.22
Amphicarpa bracteata	1.00	1.39	0.21	0.01	0.02	0.22
Aplectrum hyemale	1.00	1.39	0.21	0.01	0.02	0.22
Arisaema dracontium	0.00	0.00	0.00	0.00	0.00	0.00
Arisaema triphyllum	0.00	0.00	0.00	0.00	0.00	0.00
Aristolochia serpentaria	0.00	0.00	0.00	0.00	0.00	0.00
Asplenium platyneuron	3.00	4.17	0.62	0.09	0.21	0.83
Aster lateriflorus	0.00	0.00	0.00	0.00	0.00	0.00
Aster ontarionis	3.00	4.17	0.62	0.26	0.59	1.22
Aster pilosus	0.00	0.00	0.00	0.00	0.00	0.00
Aster simplex	0.00	0.00	0.00	0.00	0.00	0.00
Bidens cf. *frondosa*	0.00	0.00	0.00	0.00	0.00	0.00
Blephelia cf. *hirsuta*	1.00	1.39	0.21	0.04	0.10	0.30
Botrychium cf. *obliquum*	2.00	2.78	0.42	0.01	0.03	0.45
Botrychium virginicum	5.00	6.94	1.04	0.07	0.16	1.20
Bromus pubescens	3.00	4.17	0.62	0.13	0.29	0.91
Cacalia atriplicifolia	0.00	0.00	0.00	0.00	0.00	0.00
Calystegia sepium	0.00	0.00	0.00	0.00	0.00	0.00
Campanula americana	0.00	0.00	0.00	0.00	0.00	0.00
Campsis radicans	0.00	0.00	0.00	0.00	0.00	0.00
Cardamine parviflora	0.00	0.00	0.00	0.00	0.00	0.00
Carex albicans	0.00	0.00	0.00	0.00	0.00	0.00
Carex blanda	6.00	8.33	1.25	0.38	0.88	2.13
Carex cephalophora	1.00	1.39	0.21	0.04	0.10	0.30
Carex cf. grisea	5.00	6.94	1.04	0.82	1.89	2.93
Carex hirsutella	0.00	0.00	0.00	0.00	0.00	0.00
Carex hirtifolia	4.00	5.56	0.83	0.81	1.87	2.71
Carex jamesii	0.00	0.00	0.00	0.00	0.00	0.00
Carex laxiflora	2.00	2.78	0.42	0.42	0.96	1.38
Carex oligocarpa	2.00	2.78	0.42	0.42	0.96	1.38
Carex radiata	6.00	8.33	1.25	1.23	2.83	4.08
Carex sp. (glabrous, 3 mm)	0.00	0.00	0.00	0.00	0.00	0.00
Carex sp. (seedling)	2.00	2.78	0.42	0.05	0.11	0.53
Carya cordiformis	1.00	1.39	0.21	0.21	0.48	0.69
Carya ovata	0.00	0.00	0.00	0.00	0.00	0.00
Carya tomentosa	0.00	0.00	0.00	0.00	0.00	0.00
Celastris scandens	0.00	0.00	0.00	0.00	0.00	0.00
Celtis occidentalis	13.00	18.06	2.70	0.50	1.15	3.86
Cercis canadensis	4.00	5.56	0.83	0.06	0.14	0.98
Chenopodium album	0.00	0.00	0.00	0.00	0.00	0.00
Chenopodium standleyanum	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 7	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Cinna arundinacea	0.00	0.00	0.00	0.00	0.00	0.00
Circaea lutetiana	11.00	15.28	2.29	0.59	1.36	3.65
Conyza canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Cornus drummondii	0.00	0.00	0.00	0.00	0.00	0.00
Cornus racemosa	0.00	0.00	0.00	0.00	0.00	0.00
Corylus americana	1.00	1.39	0.21	0.21	0.48	0.69
Cryptotaenia canadensis	10.00	13.89	2.08	0.21	0.48	2.56
Cystopteris protrusa	4.00	5.56	0.83	0.13	0.30	1.14
Desmodium glutinosum	0.00	0.00	0.00	0.00	0.00	0.00
Dichanthelium acuminatum	0.00	0.00	0.00	0.00	0.00	0.00
Dichanthelium boscii	0.00	0.00	0.00	0.00	0.00	0.00
Dichanthelium clandestinum	1.00	1.39	0.21	0.04	0.10	0.30
Dichanthelium villosissimum	0.00	0.00	0.00	0.00	0.00	0.00
dicot 2 (Lobelia inflata?) seedling	0.00	0.00	0.00	0.00	0.00	0.00
dicot 3 seedling	1.00	1.39	0.21	0.01	0.02	0.22
Dioscorea villosa	4.00	5.56	0.83	0.13	0.30	1.14
Diospyros virginiana	0.00	0.00	0.00	0.00	0.00	0.00
Elaeagnus umbellata	0.00	0.00	0.00	0.00	0.00	0.00
Elymus hystrix	1.00	1.39	0.21	0.04	0.10	0.30
Elymus villosus	0.00	0.00	0.00	0.00	0.00	0.00
Elymus virginicus	5.00	6.94	1.04	0.85	1.97	3.01
Erechtites hieracifolia	0.00	0.00	0.00	0.00	0.00	0.00
Erigeron annuus	1.00	1.39	0.21	0.04	0.10	0.30
Euonymus atropurpureus	1.00	1.39	0.21	0.21	0.48	0.69
Eupatorium altissimum	0.00	0.00	0.00	0.00	0.00	0.00
Eupatorium purpureum	1.00	1.39	0.21	0.52	1.20	1.41
Eupatorium rugosum	18.00	25.00	3.74	1.21	2.79	6.53
Eupatorium serotinum	0.00	0.00	0.00	0.00	0.00	0.00
Festuca obtusa	18.00	25.00	3.74	0.98	2.26	6.00
Festuca pratensis	0.00	0.00	0.00	0.00	0.00	0.00
Fraxinus americana	0.00	0.00	0.00	0.00	0.00	0.00
Galium aparine	1.00	1.39	0.21	0.01	0.02	0.22
Galium circaezans	2.00	2.78	0.42	0.05	0.11	0.53
Galium concinnum	1.00	1.39	0.21	0.04	0.10	0.30
Galium triflorum	4.00	5.56	0.83	0.58	1.33	2.16
Geranium maculatum	2.00	2.78	0.42	0.08	0.19	0.61
Geum canadense	18.00	25.00	3.74	0.74	1.71	5.46
Gleditsia triacanthos	0.00	0.00	0.00	0.00	0.00	0.00
Hackelia virginica	0.00	0.00	0.00	0.00	0.00	0.00
Helianthus strumosus	0.00	0.00	0.00	0.00	0.00	0.00
Hydrophyllum virginianum	1.00	1.39	0.21	0.21	0.48	0.69
Impatiens capensis	1.00	1.39	0.21	0.04	0.10	0.30
Ipomoea sp.	1.00	1.39	0.21	0.04	0.10	0.30
Juniperus virginiana	0.00	0.00	0.00	0.00	0.00	0.00
Lactuca biennis	0.00	0.00	0.00	0.00	0.00	0.00
Lactuca canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Leersia virginica	1.00	1.39	0.21	0.04	0.10	0.30
Lespedeza sp.	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 7	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Lonicera maackii	31.00	43.06	6.44	2.99	6.89	13.33
Menispermum canadense	5.00	6.94	1.04	0.10	0.24	1.28
Monarda bradburiana	0.00	0.00	0.00	0.00	0.00	0.00
Morus alba	0.00	0.00	0.00	0.00	0.00	0.00
Morus rubra	0.00	0.00	0.00	0.00	0.00	0.00
Muhlenbergia schreberi	1.00	1.39	0.21	0.01	0.02	0.22
Muhlenbergia sobolifera	0.00	0.00	0.00	0.00	0.00	0.00
Osmorhiza longistylis	2.00	2.78	0.42	0.01	0.03	0.45
Oxalis dillenii/stricta	1.00	1.39	0.21	0.01	0.02	0.22
Oxalis fontana	0.00	0.00	0.00	0.00	0.00	0.00
Parietaria pensylvanica	0.00	0.00	0.00	0.00	0.00	0.00
Parthenocissus quinquefolia	51.00	70.83	10.60	7.31	16.85	27.45
Penstemon calycosa	0.00	0.00	0.00	0.00	0.00	0.00
Phlox divaricata	0.00	0.00	0.00	0.00	0.00	0.00
Phryma leptostachya	3.00	4.17	0.62	0.09	0.21	0.83
Physalis sp.	0.00	0.00	0.00	0.00	0.00	0.00
Phytolacca americana	0.00	0.00	0.00	0.00	0.00	0.00
Pilea pumila	8.00	11.11	1.66	0.09	0.21	1.87
Poa pratensis	0.00	0.00	0.00	0.00	0.00	0.00
Poa sylvestris	8.00	11.11	1.66	0.97	2.23	3.89
Poaceae (cf. Agrostis sp.)	0.00	0.00	0.00	0.00	0.00	0.00
Podophyllum peltatum	1.00	1.39	0.21	0.21	0.48	0.69
Polygonatum commutatum	1.00	1.39	0.21	0.04	0.10	0.30
Polygonum cristatum	0.00	0.00	0.00	0.00	0.00	0.00
Polygonum virginicum	9.00	12.50	1.87	0.27	0.62	2.50
Polygonum sp.	0.00	0.00	0.00	0.00	0.00	0.00
Prenanthes sp.	0.00	0.00	0.00	0.00	0.00	0.00
Prunus serotina	2.00	2.78	0.42	0.05	0.11	0.53
Ptelea trifoliata	0.00	0.00	0.00	0.00	0.00	0.00
Quercus alba	0.00	0.00	0.00	0.00	0.00	0.00
Quercus imbricaria	2.00	2.78	0.42	0.05	0.11	0.53
Quercus muhlenbergii	1.00	1.39	0.21	0.21	0.48	0.69
Quercus rubra	0.00	0.00	0.00	0.00	0.00	0.00
Quercus velutina	0.00	0.00	0.00	0.00	0.00	0.00
Ranunculus abortivus	0.00	0.00	0.00	0.00	0.00	0.00
Ranunculus septentrionalis	0.00	0.00	0.00	0.00	0.00	0.00
Rhus aromatica	0.00	0.00	0.00	0.00	0.00	0.00
Ribes missouriense	0.00	0.00	0.00	0.00	0.00	0.00
Rosa multiflora	4.00	5.56	0.83	0.30	0.69	1.52
Rubus allegheniensis	0.00	0.00	0.00	0.00	0.00	0.00
Rubus flagellaris	0.00	0.00	0.00	0.00	0.00	0.00
Rubus pensylvanicus	0.00	0.00	0.00	0.00	0.00	0.00
Sanicula canadensis	7.00	9.72	1.46	1.68	3.88	5.33
Sanicula odorata	45.00	62.50	9.36	5.44	12.56	21.91
Sassafras albicans	2.00	2.78	0.42	0.01	0.03	0.45
Scutellaria incana	0.00	0.00	0.00	0.00	0.00	0.00
Silene stellata	2.00	2.78	0.42	0.05	0.11	0.53
Smilacina racemosa	6.00	8.33	1.25	0.25	0.58	1.82

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 7	occurrences (72 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Smilax ecirrhata	0.00	0.00	0.00	0.00	0.00	0.00
Smilax hispida	15.00	20.83	3.12	0.58	1.35	4.46
Smilax lasioneuron	0.00	0.00	0.00	0.00	0.00	0.00
Solidago canadensis	0.00	0.00	0.00	0.00	0.00	0.00
Solidago ulmifolia	1.00	1.39	0.21	0.04	0.10	0.30
Specularia perfoliata	0.00	0.00	0.00	0.00	0.00	0.00
Staphylea trifolia	12.00	16.67	2.49	3.78	8.73	11.22
Symphoricarpos orbiculatus	10.00	13.89	2.08	0.78	1.79	3.87
Teucrium canadense	0.00	0.00	0.00	0.00	0.00	0.00
Toxicodendron radicans	5.00	6.94	1.04	0.34	0.78	1.82
Trillium recurvatum	0.00	0.00	0.00	0.00	0.00	0.00
Ulmus rubra	31.00	43.06	6.44	3.81	8.78	15.22
Vernonia sp.	2.00	2.78	0.42	0.05	0.11	0.53
Verbesina helianthoides	0.00	0.00	0.00	0.00	0.00	0.00
Veronicastrum virginicum	0.00	0.00	0.00	0.00	0.00	0.00
Viola pensylvanica pubescens	0.00	0.00	0.00	0.00	0.00	0.00
Viola pratincola	0.00	0.00	0.00	0.00	0.00	0.00
Viola sororia	16.00	22.22	3.33	0.49	1.12	4.45
Viola triloba	1.00	1.39	0.21	0.04	0.10	0.30
Vitis cinerea	0.00	0.00	0.00	0.00	0.00	0.00
Vitis riparia	14.00	19.44	2.91	0.17	0.38	3.29
Woodsia obtusa	1.00	1.39	0.21	0.21	0.48	0.69
Zanthoxylem americanum	0.00	0.00	0.00	0.00	0.00	0.00
			100.00		100.00	200.00

SUMMARY DATA

Total Species # (72 quadrats)	78
Percent Cover	43.36
Species Density/0.25-m^2	6.68

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 15	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Bare Ground				42.01		
Acalypha rhomboidea	0	0	0	0	0	0
Acalypha virginica	3	8.333333	1.530612	0.041667	0.080043	1.610655
Acer saccharinum	0	0	0	0	0	0
Agastache nepetoides	0	0	0	0	0	0
Agrimonia pubescens	0	0	0	0	0	0
Agrimonia rostellata	0	0	0	0	0	0
Allium canadense	0	0	0	0	0	0
Amphicarpa bracteata	0	0	0	0	0	0
Aplectrum hyemale	0	0	0	0	0	0
Arisaema dracontium	0	0	0	0	0	0
Arisaema triphyllum	8	22.22222	4.081633	1.680556	3.228388	7.310021
Aristolochia serpentaria	0	0	0	0	0	0
Asplenium platyneuron	0	0	0	0	0	0
Aster lateriflorus	2	5.555556	1.020408	0.5	0.960512	1.98092
Aster ontarionis	0	0	0	0	0	0
Aster pilosus	0	0	0	0	0	0
Aster simplex	0	0	0	0	0	0
Bidens cf. *frondosa*	0	0	0	0	0	0
Blephelia cf. *hirsuta*	0	0	0	0	0	0
Botrychium cf. *obliquum*	0	0	0	0	0	0
Botrychium virginicum	0	0	0	0	0	0
Bromus pubescens	0	0	0	0	0	0
Cacalia atriplicifolia	0	0	0	0	0	0
Calystegia sepium	0	0	0	0	0	0
Campanula americana	1	2.777778	0.510204	0.416667	0.800427	1.310631
Campsis radicans	0	0	0	0	0	0
Cardamine parviflora	0	0	0	0	0	0
Carex albicans	0	0	0	0	0	0
Carex blanda	7	19.44444	3.571429	1.513889	2.908218	6.479646
Carex cephalophora	4	11.11111	2.040816	0.666667	1.280683	3.321499
Carex cf. grisea	0	0	0	0	0	0
Carex hirsutella	0	0	0	0	0	0
Carex hirtifolia	1	2.777778	0.510204	0.083333	0.160085	0.670289
Carex jamesii	0	0	0	0	0	0
Carex laxiflora	0	0	0	0	0	0
Carex oligocarpa	0	0	0	0	0	0
Carex radiata	0	0	0	0	0	0
Carex sp. (glabrous, 3 mm)	1	2.777778	0.510204	0.083333	0.160085	0.670289
Carex sp. (seedling)	1	2.777778	0.510204	0.013889	0.026681	0.536885
Carya cordiformis	0	0	0	0	0	0
Carya ovata	2	5.555556	1.020408	0.097222	0.186766	1.207174
Carya tomentosa	0	0	0	0	0	0
Celastris scandens	0	0	0	0	0	0
Celtis occidentalis	3	8.333333	1.530612	0.25	0.480256	2.010868
Cercis canadensis	0	0	0	0	0	0
Chenopodium album	0	0	0	0	0	0
Chenopodium standleyanum	0	0	0	0	0	0

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 15	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Cinna arundinacea	0	0	0	0	0	0
Circaea lutetiana	13	36.11111	6.632653	4.236111	8.137673	14.77033
Conyza canadensis	0	0	0	0	0	0
Cornus drummondii	0	0	0	0	0	0
Cornus racemosa	0	0	0	0	0	0
Corylus americana	0	0	0	0	0	0
Cryptotaenia canadensis	2	5.555556	1.020408	0.166667	0.320171	1.340579
Cystopteris protrusa	5	13.88889	2.55102	0.416667	0.800427	3.351447
Desmodium glutinosum	0	0	0	0	0	0
Dichanthelium acuminatum	0	0	0	0	0	0
Dichanthelium boscii	0	0	0	0	0	0
Dichanthelium clandestinum	0	0	0	0	0	0
Dichanthelium villosissimum	0	0	0	0	0	0
dicot 2 (Lobelia inflata?) seedling	0	0	0	0	0	0
dicot 3 seedling	0	0	0	0	0	0
Dioscorea villosa	0	0	0	0	0	0
Diospyros virginiana	1	2.777778	0.510204	0.083333	0.160085	0.670289
Elaeagnus umbellata	0	0	0	0	0	0
Elymus hystrix	0	0	0	0	0	0
Elymus villosus	0	0	0	0	0	0
Elymus virginicus	0	0	0	0	0	0
Erechtites hieracifolia	0	0	0	0	0	0
Erigeron annuus	0	0	0	0	0	0
Euonymus atropurpureus	0	0	0	0	0	0
Eupatorium altissimum	0	0	0	0	0	0
Eupatorium purpureum	0	0	0	0	0	0
Eupatorium rugosum	14	38.88889	7.142857	2.916667	5.602988	12.74585
Eupatorium serotinum	3	8.333333	1.530612	0.111111	0.213447	1.744059
Festuca obtusa	0	0	0	0	0	0
Festuca pratensis	0	0	0	0	0	0
Fraxinus americana	1	2.777778	0.510204	0.083333	0.160085	0.670289
Galium aparine	0	0	0	0	0	0
Galium circaezans	0	0	0	0	0	0
Galium concinnum	0	0	0	0	0	0
Galium triflorum	0	0	0	0	0	0
Geranium maculatum	0	0	0	0	0	0
Geum canadense	2	5.555556	1.020408	0.097222	0.186766	1.207174
Gleditsia triacanthos	0	0	0	0	0	0
Hackelia virginica	1	2.777778	0.510204	0.083333	0.160085	0.670289
Helianthus strumosus	0	0	0	0	0	0
Hydrophyllum virginianum	0	0	0	0	0	0
Impatiens capensis	35	97.22222	17.85714	16.11111	30.94984	48.80698
Ipomoea sp.	0	0	0	0	0	0
Juniperus virginiana	0	0	0	0	0	0
Lactuca biennis	0	0	0	0	0	0
Lactuca canadensis	0	0	0	0	0	0
Leersia virginica	0	0	0	0	0	0
Lespedeza sp.	0	0	0	0	0	0

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 15	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Lonicera maackii	0	0	0	0	0	0
Menispermum canadense	0	0	0	0	0	0
Monarda bradburiana	0	0	0	0	0	0
Morus alba	0	0	0	0	0	0
Morus rubra	0	0	0	0	0	0
Muhlenbergia schreberi	0	0	0	0	0	0
Muhlenbergia sobolifera	0	0	0	0	0	0
Osmorhiza longistylis	0	0	0	0	0	0
Oxalis dillenii/stricta	0	0	0	0	0	0
Oxalis fontana	0	0	0	0	0	0
Parietaria pensylvanica	0	0	0	0	0	0
Parthenocissus quinquefolia	28	77.77778	14.28571	8.444444	16.22199	30.5077
Penstemon calycosa	3	8.333333	1.530612	0.180556	0.346852	1.877464
Phlox divaricata	0	0	0	0	0	0
Phryma leptostachya	1	2.777778	0.510204	0.083333	0.160085	0.670289
Physalis sp.	0	0	0	0	0	0
Phytolacca americana	0	0	0	0	0	0
Pilea pumila	7	19.44444	3.571429	0.236111	0.453575	4.025004
Poa pratensis	0	0	0	0	0	0
Poa sylvestris	4	11.11111	2.040816	2.319444	4.45571	6.496526
Poaceae (cf. Agrostis sp.)	0	0	0	0	0	0
Podophyllum peltatum	1	2.777778	0.510204	0.416667	0.800427	1.310631
Polygonatum commutatum	2	5.555556	1.020408	0.5	0.960512	1.98092
Polygonum cristatum	0	0	0	0	0	0
Polygonum virginicum	1	2.777778	0.510204	0.083333	0.160085	0.670289
Polygonum sp.	0	0	0	0	0	0
Prenanthes sp.	0	0	0	0	0	0
Prunus serotina	0	0	0	0	0	0
Ptelea trifoliata	0	0	0	0	0	0
Quercus alba	0	0	0	0	0	0
Quercus imbricaria	0	0	0	0	0	0
Quercus muhlenbergii	0	0	0	0	0	0
Quercus rubra	0	0	0	0	0	0
Quercus velutina	1	2.777778	0.510204	0.013889	0.026681	0.536885
Ranunculus abortivus	0	0	0	0	0	0
Ranunculus septentrionalis	0	0	0	0	0	0
Rhus aromatica	0	0	0	0	0	0
Ribes missouriense	3	8.333333	1.530612	0.583333	1.120598	2.65121
Rosa multiflora	0	0	0	0	0	0
Rubus allegheniensis	0	0	0	0	0	0
Rubus flagellaris	0	0	0	0	0	0
Rubus pensylvanicus	0	0	0	0	0	0
Sanicula canadensis	0	0	0	0	0	0
Sanicula odorata	11	30.55556	5.612245	3.805556	7.310566	12.92281
Sassafras albicans	2	5.555556	1.020408	0.430556	0.827108	1.847516
Scutellaria incana	0	0	0	0	0	0
Silene stellata	0	0	0	0	0	0
Smilacina racemosa	4	11.11111	2.040816	1.666667	3.201708	5.242524

Appendix 3.

Baseline (2003) Ground Cover Data - Unit 15	occurrences (36 plots)	% frequency	rel. freq.	% Cover	Rel. Cover	IV200
Smilax ecirrhata	0	0	0	0	0	0
Smilax hispida	0	0	0	0	0	0
Smilax lasioneuron	0	0	0	0	0	0
Solidago canadensis	2	5.555556	1.020408	0.097222	0.186766	1.207174
Solidago ulmifolia	0	0	0	0	0	0
Specularia perfoliata	0	0	0	0	0	0
Staphylea trifolia	0	0	0	0	0	0
Symphoricarpos orbiculatus	0	0	0	0	0	0
Teucrium canadense	0	0	0	0	0	0
Toxicodendron radicans	0	0	0	0	0	0
Trillium recurvatum	0	0	0	0	0	0
Ulmus rubra	6	16.66667	3.061224	2.791667	5.36286	8.424085
Vernonia sp.	0	0	0	0	0	0
Verbesina helianthoides	0	0	0	0	0	0
Veronicastrum virginicum	0	0	0	0	0	0
Viola pensylvanica pubescens	0	0	0	0	0	0
Viola pratincola	0	0	0	0	0	0
Viola sororia	6	16.66667	3.061224	0.222222	0.426894	3.488119
Viola triloba	0	0	0	0	0	0
Vitis cinerea	0	0	0	0	0	0
Vitis riparia	3	8.333333	1.530612	0.111111	0.213447	1.744059
Woodsia obtusa	0	0	0	0	0	0
Zanthoxylem americanum	1	2.777778	0.510204	0.416667	0.800427	1.310631
			100		100	200

SUMMARY DATA

Total Species # (72 quadrats)	39
Percent Cover	52.05
Species Density/0.25-m^2	5.44

Appendix 4. Comparison of live tree density/ha, basal area (m^2/ha), % frequency of occurrence, and IV 300 for each unit at Chip-o-Will Woods 2003.

Unit	B				C				D1				D2			
	Density/ ha	Basal Area m^2/ha	% Frequenc of Occurrence	IV 300	Density/ ha	Basal Area m^2/ha	% Frequenc of Occurrence	IV 300	Density/ ha	Basal Area m^2/ha	% Frequenc of Occurrence	IV 300	Density/ ha	Basal Area m^2/ha	% Frequenc of Occurrence	IV 300
Acer negundo	0.0	0.00	0.0	0.0	2.2	0.01	11.1	2.7	3.3	0.01	16.7	3.2	0.0	0.00	0.0	0.0
Carya laciniosa	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	6.7	0.01	33.3	6.5	0.0	0.00	0.0	0.0
Carya ovata	133.3	2.14	88.9	50.5	17.8	0.18	44.4	12.9	36.7	0.41	50.0	16.3	33.3	0.46	100.0	31.7
Carya texana	11.1	0.03	22.2	6.5	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0
Carya tomentosa	6.7	0.05	22.2	5.7	13.3	0.15	11.1	5.1	3.3	0.01	16.7	3.2	0.0	0.00	0.0	0.0
Celtis laevigata	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	3.3	0.01	16.7	3.2	0.0	0.00	0.0	0.0
Celtis occidentalis	2.2	0.01	11.1	2.6	2.2	0.03	11.1	2.8	0.0	0.00	0.0	0.0	6.7	0.02	33.3	8.7
Cercis canadensis	0.0	0.00	0.0	0.0	11.1	0.04	11.1	4.3	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0
Crataegus sp.	0.0	0.00	0.0	0.0	4.4	0.01	11.1	3.1	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0
Diospyros virginiana	0.0	0.00	0.0	0.0	8.9	0.06	44.4	11.0	13.3	0.06	50.0	10.5	6.7	0.07	66.7	15.6
Fraxinus americana	0.0	0.00	0.0	0.0	2.2	0.01	11.1	2.7	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0
Gleditsia triacanthos	0.0	0.00	0.0	0.0	2.2	0.00	11.1	2.7	3.3	0.02	16.7	3.3	0.0	0.00	0.0	0.0
Prunus serotina	13.3	0.10	33.3	9.4	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	6.7	0.04	33.3	8.8
Quercus bicolor	0.0	0.00	0.0	0.0	15.6	1.22	22.2	11.6	33.3	1.80	50.0	20.9	0.0	0.00	0.0	0.0
Quercus imbricaria	4.4	0.05	22.2	5.3	0.0	0.00	0.0	0.0	6.7	0.02	33.3	6.5	0.0	0.00	0.0	0.0
Quercus marilandica	33.3	0.50	66.7	21.2	71.1	1.41	55.6	28.5	36.7	0.85	83.3	23.1	20.0	0.77	100.0	29.0
Quercus palustris	4.4	0.02	11.1	3.1	17.8	0.23	33.3	10.8	6.7	0.05	16.7	4.0	0.0	0.00	0.0	0.0
Quercus rubra	0.0	0.00	0.0	0.0	6.7	0.05	11.1	3.6	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0
Quercus stellata	240.0	20.66	100.0	148.8	335.6	24.35	100.0	163.0	256.7	22.37	100.0	149.5	240.0	23.07	100.0	184.2
Quercus velutina	66.7	0.39	55.6	24.6	8.9	0.07	22.2	6.4	13.3	0.12	50.0	10.7	0.0	0.00	0.0	0.0
Sassafras albidum	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	13.3	0.05	33.3	7.9	0.0	0.00	0.0	0.0
Ulmus rubra	33.3	0.21	77.8	22.1	77.8	0.52	66.7	28.8	86.7	0.50	83.3	31.3	26.7	0.21	66.7	22.0
TOTALS	**548.9**	**24.16**	**511.1**	**300.0**	**597.8**	**28.34**	**477.8**	**300.0**	**523.3**	**26.29**	**650.0**	**300.0**	**340.0**	**24.65**	**500.0**	**300.0**

Appendix 5. Summary of shrub-sapling data from each unit at Chip-O-Will Woods.

	Unit B		Unit C		Unit D1		Unit D2	
	Total Density	IV 200	Total Density	IV 200	Total Density	IV 200	Total Density	IV 200
SPECIES								
Acer negundo	0	0.00	4	3.73	4	4.47	1	3.62
Campsis radicans	6	3.39	23	9.42	7	2.70	0	0.00
Carya laciniosa	0	0.00	0	0.00	2	1.63	0	0.00
Carya ovata	3	6.41	3	4.70	3	3.05	2	7.24
Carya texana	2	2.39	0	0.00	0	0.00	0	0.00
Celtis laevigata	1	2.14	0	0.00	0	0.00	0	0.00
Celtis occidentalis	2	2.39	4	5.00	3	3.05	5	9.02
Cercis canadensis	0	0.00	2	3.13	0	0.00	0	0.00
Crataegus crus-galli	0	0.00	0	0.00	1	1.42	0	0.00
Crataegus sp. cuneate leaf base	0	0.00	1	1.57	0	0.00	0	0.00
Diospyros virginiana	0	0.00	15	13.35	7	6.32	1	3.62
Euonymus atropurpureus	0	0.00	0	0.00	1	1.42	0	0.00
Fraxinus americana	0	0.00	0	0.00	0	0.00	0	0.00
Fraxinus pennsylvanicus	2	4.27	11	12.15	16	11.85	4	11.46
Ilex decidua	0	0.00	0	0.00	8	5.32	3	7.84
Parthenocissus quinquefolia	0	0.00	1	1.57	3	3.05	1	3.62
Prunus serotina	3	4.53	4	2.46	6	3.69	3	4.81
Prunus sp.	0	0.00	1	1.57	0	0.00	0	0.00
Quercus bicolor	0	0.00	3	2.16	13	7.60	1	3.62
Quercus imbricaria	1	2.14	0	0.00	0	0.00	0	0.00
Quercus marilandica	5	8.80	20	16.11	7	5.11	2	4.21
Quercus palustris	9	11.69	6	8.13	8	6.53	6	9.61
Quercus rubra	1	2.14	6	4.33	0	0.00	0	0.00
Quercus stellata	52	20.58	18	14.25	9	5.54	5	9.02
Quercus velutina	19	17.97	2	3.13	3	3.05	0	0.00
Rosa multiflora	0	0.00	0	0.00	12	7.38	6	6.58
Rosa setigera	0	0.00	6	3.06	43	11.60	0	0.00
Rubus flagellaris	180	67.75	104	41.26	32	10.45	28	22.63
Rubus pensylvanicus	104	35.50	84	32.74	46	13.44	74	49.85
Sassafras albidum	0	0.00	1	1.57	33	11.87	2	7.24
Smilax hispida	0	0.00	0	0.00	5	4.68	1	3.62
Toxicodendron radicans	8	5.78	3	2.16	176	46.04	21	21.52
Ulmus rubra	1	2.14	10	10.59	15	12.84	2	7.24
Vitis cinerea	0	0.00	0	0.00	1	1.42	1	3.62
Vitis riparia	0	0.00	2	1.86	4	4.47	0	0.00
TOTALS	399	200.00	334	200.00	468	200.00	169	200

Appendix 6a. Summary baseline ground-cover data from Unit B, a fire treatment unit, Chip-O-Will Woods, Washington County.

Unit B	occurrences (108 plots)	% freq	% Cover	Total Cover (27 m^2)	IV200
BARE GROUND	108	100.00	79.722	21.525	
Parthenocissus quinquefolia	31	28.70	2.574	0.695	27.718
Rubus flagellaris	22	20.37	3.042	0.821	25.545
Carex glaucodea	17	15.74	1.644	0.444	16.322
Agrostis perennans	11	10.19	2.213	0.598	16.119
Cinna arundinacaea	15	13.89	0.991	0.268	12.180
Carex festucacea	7	6.48	1.398	0.378	10.209
Helianthus strumosus	5	4.63	1.319	0.356	8.843
Leersia virginica	6	5.56	1.014	0.274	7.858
Carex 1 sterile	2	1.85	1.134	0.306	6.470
Quercus stellata	6	5.56	0.662	0.179	6.157
Eleocharis verrucosa	4	3.70	0.764	0.206	5.664
Carex albicans	8	7.41	0.329	0.089	5.530
Podophyllum peltatum	3	2.78	0.833	0.225	5.507
Rubus sp.	7	6.48	0.125	0.034	4.053
Polygonum cf. *hydropiperoides*	2	1.85	0.606	0.164	3.918
Impatiens capensis	2	1.85	0.486	0.131	3.336
Dichanthelium acuminatum	6	5.56	0.074	0.020	3.314
Acalypha virginica/gracilens	6	5.56	0.028	0.008	3.090
Geum canadense	2	1.85	0.352	0.095	2.687
Carex annectens	2	1.85	0.278	0.075	2.328
Allium canadense	3	2.78	0.037	0.010	1.657
Ulmus rubra	3	2.78	0.037	0.010	1.657
Viola pratincola	3	2.78	0.037	0.010	1.657
Carya ovata	2	1.85	0.056	0.015	1.254
Galium obtusum	1	0.93	0.139	0.038	1.164
Muhlenbergia sp.	1	0.93	0.139	0.038	1.164
Prunus serotina	1	0.93	0.139	0.038	1.164
Acer rubrum	2	1.85	0.009	0.003	1.030
Oxalis stricta/dillenii	2	1.85	0.009	0.003	1.030
Parietaria pennsylvanica	2	1.85	0.009	0.003	1.030
Vitis riparia	2	1.85	0.009	0.003	1.030
Diospyros virginiana	1	0.93	0.028	0.008	0.627
Gillenia stipulata	1	0.93	0.028	0.008	0.627
Prunella vulgaris	1	0.93	0.028	0.008	0.627
Rosa multiflora	1	0.93	0.028	0.008	0.627
Rubus pensilvanicus	1	0.93	0.028	0.008	0.627
Acer saccharinum	1	0.93	0.005	0.001	0.515
Apocynum cannabinum	1	0.93	0.005	0.001	0.515
Celtis occidentalis	1	0.93	0.005	0.001	0.515
Dicot seedling	1	0.93	0.005	0.001	0.515
Euphorbia corollata	1	0.93	0.005	0.001	0.515
Fraxinus pennsylvanica	1	0.93	0.005	0.001	0.515

Unit B	occurrences (108 plots)	% freq	% Cover	Total Cover (27 m^2)	IV200
Lindernia dubia var. *anagallidea*	1	0.93	0.005	0.001	0.515
Lobelia inflata	1	0.93	0.005	0.001	0.515
Ludwigia palustris	1	0.93	0.005	0.001	0.515
Parthenium integrifolium	1	0.93	0.005	0.001	0.515
Quercus marilandica/velutina	1	0.93	0.005	0.001	0.515
Viola sagittata	1	0.93	0.005	0.001	0.515
			20.68	5.58	200.00

avg. spp density	1.88
% cover	20.68
spp richness	48

Appendix 6b. Summary baseline ground-cover data from Unit C, a fire treatment unit, Chip-O-Will Woods, Washington County.

Unit C	occur-rences (108 plots)	% freq	% Cover	Total Cover (27 m^2)	IV200
BARE GROUND	108	100.00	79.074	21.350	
Parthenocissus quinquefolia	27	25.00	4.755	1.284	41.806
Rubus flagellaris	23	21.30	4.731	1.278	39.024
Eleocharis verrucosa	12	11.11	5.176	1.398	33.916
Quercus stellata	13	12.04	1.523	0.411	16.293
Acer saccharinum	12	11.11	0.125	0.034	8.626
Vitis cinerea	6	5.56	0.255	0.069	5.275
Impatiens capensis	6	5.56	0.208	0.056	5.043
Ulmus rubra	6	5.56	0.185	0.050	4.927
Vitis riparia	2	1.85	0.694	0.188	4.810
Quercus palustris	5	4.63	0.046	0.013	3.565
Carex festucacea	2	1.85	0.352	0.095	3.095
Acalypha virginica/gracilens	4	3.70	0.042	0.011	2.875
Diospyros virginiana	3	2.78	0.171	0.046	2.858
Potentilla simplex	3	2.78	0.171	0.046	2.858
Carex albicans	2	1.85	0.278	0.075	2.724
Pycnanthemum tenuifolium	2	1.85	0.278	0.075	2.724
Agrostis perennans	3	2.78	0.037	0.010	2.185
Rubus sp.	2	1.85	0.056	0.015	1.611
Allium canadense	2	1.85	0.032	0.009	1.496
Oxalis stricta/dillenii	2	1.85	0.032	0.009	1.496
Dichanthelium acuminatum	2	1.85	0.009	0.003	1.380
Apocynum cannabinum	1	0.93	0.139	0.038	1.362
Carex caroliniana	1	0.93	0.139	0.038	1.362
Carex cf. *cephaloidea*	1	0.93	0.139	0.038	1.362
Geum canadense	1	0.93	0.139	0.038	1.362
Helianthus strumosus	1	0.93	0.139	0.038	1.362
Cinna arundinacaea	1	0.93	0.028	0.008	0.806
Dichanthelium villosissimum	1	0.93	0.028	0.008	0.806
Erechtites hieraciifolia	1	0.93	0.028	0.008	0.806
Galium obtusum	1	0.93	0.028	0.008	0.806
Fraxinus pennsylvanica	1	0.93	0.005	0.001	0.690
Quercus marilandica	1	0.93	0.005	0.001	0.690
			19.972	5.393	200.000

avg. spp density	1.39
% cover	19.97
spp richness	32

Appendix 6c. Summary baseline ground-cover data from Units D1 and D2 combined, fire-free reference units, Chip-O-Will Woods, Washington County.

Unit D	occur-rences (108 plots)	% freq	% Cover	Total Cover (27 m^2)	IV200
BARE GROUND	108	100.00	76.389	20.625	
Parthenocissus quinquefolia	39	36.11	4.551	1.229	37.260
Rubus flagellaris	30	27.78	2.870	0.775	25.819
Carex cf. *pellita*	9	8.33	1.639	0.443	11.253
Cinna arundinacaea	13	12.04	0.912	0.246	9.692
Parthenium integrifolium	6	5.56	1.356	0.366	8.692
Quercus stellata	14	12.96	0.537	0.145	8.430
Lonicera japonica	4	3.70	1.435	0.388	8.189
Carex annectens	2	1.85	1.157	0.313	6.078
Acer saccharinum	11	10.19	0.120	0.033	5.264
Carex festucacea	4	3.70	0.764	0.206	5.161
Toxicodendron radicans	5	4.63	0.523	0.141	4.505
Rubus pensilvanicus	4	3.70	0.542	0.146	4.159
Leersia virginica	3	2.78	0.634	0.171	4.148
Galium obtusum	2	1.85	0.718	0.194	4.094
Dichanthelium acuminatum	5	4.63	0.426	0.115	4.067
Eleocharis verrucosa	3	2.78	0.514	0.139	3.605
Carex caroliniana	3	2.78	0.491	0.133	3.500
Impatiens capensis	7	6.48	0.102	0.028	3.464
Quercus palustris	5	4.63	0.250	0.068	3.273
Rosa setigera	3	2.78	0.380	0.103	2.999
Allium canadense	4	3.70	0.222	0.060	2.719
Amphicarpaea bracteata	2	1.85	0.352	0.095	2.445
Ulmus rubra	5	4.63	0.023	0.006	2.250
Viola pratincola	5	4.63	0.023	0.006	2.250
Euthamia graminifolia	2	1.85	0.278	0.075	2.111
Carya ovata	1	0.93	0.347	0.094	1.995
Erechtites hieraciifolia	4	3.70	0.042	0.011	1.905
Acalypha virginica/gracilens	4	3.70	0.019	0.005	1.800
Diospyros virginiana	3	2.78	0.083	0.023	1.663
Eleocharis wolfii	2	1.85	0.167	0.045	1.610
Agrostis perennans	3	2.78	0.037	0.010	1.455
Tradescantia ohiensis	2	1.85	0.056	0.015	1.109
Andropogon gerardii	1	0.93	0.139	0.038	1.055
Carex albicans	1	0.93	0.139	0.038	1.055
Sassafras albidum	1	0.93	0.139	0.038	1.055
Apocynum cannabinum	2	1.85	0.032	0.009	1.005
Dicot seedling	2	1.85	0.009	0.003	0.900
Helianthus strumosus	2	1.85	0.009	0.003	0.900
Oxalis stricta/dillenii	2	1.85	0.009	0.003	0.900
Potentilla simplex	2	1.85	0.009	0.003	0.900
Ipomoea sp.	1	0.93	0.028	0.008	0.554
Quercus velutina	1	0.93	0.028	0.008	0.554
Vitis cinerea	1	0.93	0.028	0.008	0.554

Appendix 6c continued.

Unit D	occur-rences (108 plots)	% freq	% Cover	Total Cover (27 m^2)	IV200
Acalypha virginica	1	0.93	0.005	0.001	0.450
Anagallis arvensis	1	0.93	0.005	0.001	0.450
Elymus virginicus	1	0.93	0.005	0.001	0.450
Fraxinus pennsylvanica	1	0.93	0.005	0.001	0.450
Lactuca canadensis	1	0.93	0.005	0.001	0.450
Oxalis violacea	1	0.93	0.005	0.001	0.450
Quercus imbricaria	1	0.93	0.005	0.001	0.450
Solidago nemoralis	1	0.93	0.005	0.001	0.450
			22.176	5.988	200.000

avg. spp density	2.16
% cover	22.18
spp richness	51